TOWARDS A

WATER SENSITIVE MEXICO CITY

Public space as a rain management strategy

AUTORIDAD DEL ESPACIO PÚBLICO

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A TASK OF SIGNIFICANCE

INTRODUCTION TO THIS STUDY

CHAPTER 1

About the collaboration

The Public Space Authority of Mexico City (Autoridad del Espacio Público; AEP) recognizes cyclical flooding and water shortages as some of the most pressing urban vulnerabilities in Mexico City (CDMX). The city faces a water paradox of simultaneous abundance and scarcity. Furthermore the city's water extraction regime is resulting in significant land subsidence, making CDMX amongst the world's fastest sinking cities.

In this context the attention of AEP has been drawn to the Netherlands given the country's renowned leadership in advanced urban waterscape design. In figuring out how to tackle the water paradox through public space, AEP has identified Rotterdam's water plazas as a crucial example. At the territorial scale it could both contribute to the redistribution of wealth in the city and mitigate the impacts of water related vulnerabilities. At the local scale it could entail the reconstruction of the city's broken relationship with water. AEP defines an ambition of combining quality public space, problem solving water management strategies and creating socially sustainable places in the urban public realm.

These ambitions coincide with the intentions of the creators of the water plaza (inventors and designers) De Urbanisten. They relate to these ambitions in their design work, which also fits into the Dutch tradition of creating productive waterscapes. Therefore AEP has taken the initiative to make contact with De Urbanisten. Given the magnitude of the problem and the scale of CDMX, contact with Deltares has been established. This leading Dutch institute on matters of hydrology and geology is renowned for strategic water management and flood resilience advice worldwide. They are the most appropriate engineering partner to collaborate with in this study. Deltares and De Urbanisten are collaborating on international projects more frequently.

Since February 2015 contact between all partners has been established on this exciting topic. Through various Skype meetings and email communication, partners have exchanged knowledge about the underlying problem and the joint goals for collaboration. All this has been kindly supported by the Latin-American Development bank and the Dutch Embassy in Mexico. As a result an intense four day workshop in CDMX has been held. Subsequently an extended elaboration of the workshop results has been translated into this report, "Towards a Water Sensitive Mexico City".

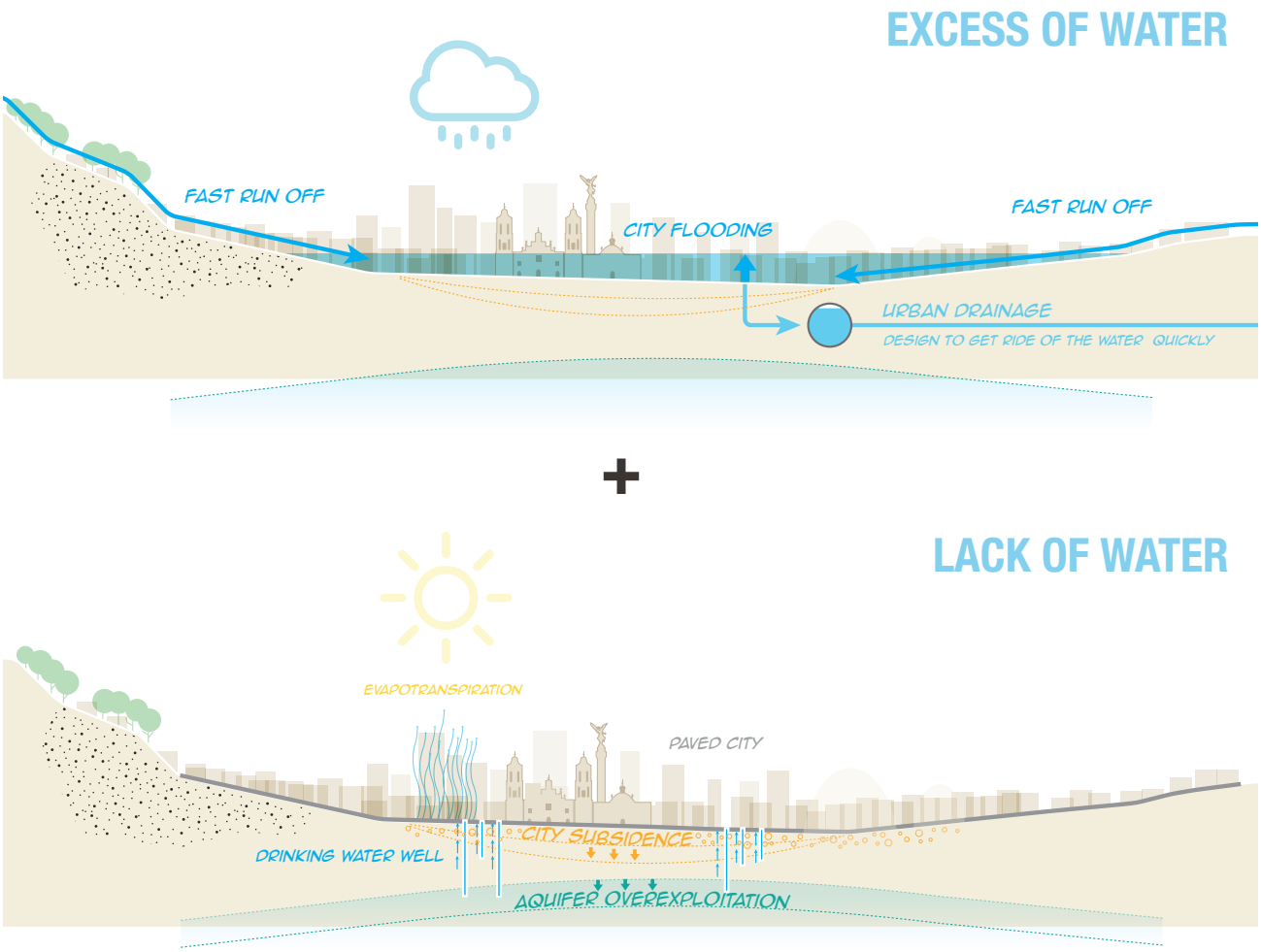
This report expresses the mutual desire for a long term relationship between the partners AEP, De Urbanisten, Deltares and wants to lay a solid foundation with its content. Knowledge, inspiration and solutions are being shared here. The main goal is to discuss how investments in water management can manifest in vibrant public spaces and to identify the feasibility and the 'how-to' approach to a water plaza in CDMX. This will require a clarification on the 'paradigm shift' that is needed to go from technical problem solving solutions to multi-purpose water sensitive strategies. Here this report wants to make a valuable contribution to and emphasize the progress that has already been made by Mexico City through AEP so far.

A water sensitive approach

Mexico City is facing serious challenges regarding its relation to water in the broadest sense possible. During the rainy season, certain parts of the city suffer from flash floods causing serious damage and danger. Causes can be found in the city's topography, its vast urbanisation and lack of open green spaces and the total dependence on an extensive subterranean drainage system. During the dry season there is a serious lack of water with significant effects on public health caused by heat stress, lack of drinking water, dehydration of vegetation and land subsidence. There is either too much or too little water in the city, and this current system is preventing the establishment of a possible balance which could be brought forth by a circular approach.

By considering its history and by acquiring a deeper understanding of its current hydrological condition, it is possible to explore possibilities to recover a water balance. In order to do so a regional system analysis is vital to understanding how the water cycle currently works and how it could work optimally. At the same time it is important to be able to put a hands-on public space strategy into practice that can offer a perspective to act directly and on a small scale. For this we propose to introduce the concept of a Water Sensitive City (Brown et.al. 2008, see diagram) to CDMX.

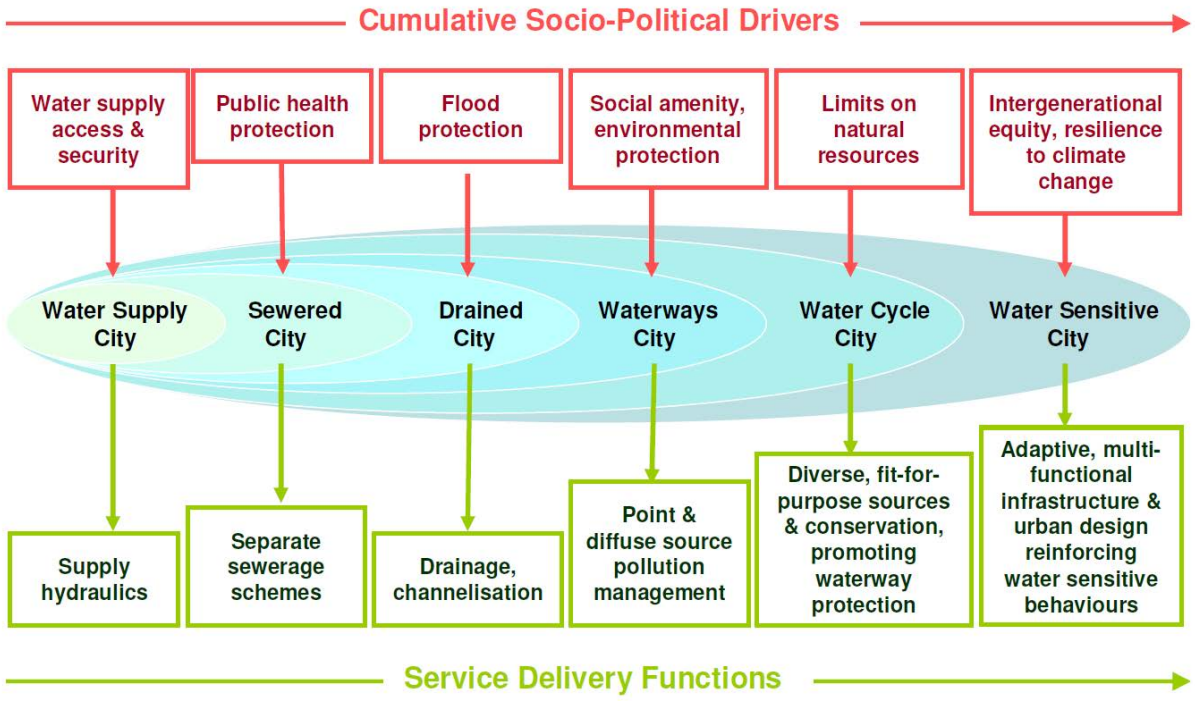
SCHEMATIZED SUMMARY OF WATER RELATED PROBLEMS CDMX IS FACING TODAY



Water sensitivity entails an adaptive multifunctional infrastructure and urban design reinforcing water sensitive behaviours. This implies offering solutions beyond the technical measures in which people are being engaged. While CDMX still is lacking some of the basics such as sufficient access to water supply and flood protection, we are convinced the answers cannot solely be found in more extensive technical systems trying to solve only one specific problem (...and often causing new problems). We are looking for answers in a more holistic approach in which public space design and water management are being integrated into a more comprehensive strategy. Here public involvement is key and only logical. Here also lies the chance of creating educational value in solving water problems and by doing so emphasizing the importance of public awareness on this issue.

These are not just utopian ambitions being drawn up here. The concept of water sensitive cities is being applied in several cities in the world and it is proving to be effective in many ways: improving public health and raising awareness, mitigating climatic issues , creating quality spaces, adding value to the city and being cost effective.

STEPS TOWARDS WATER SENSITIVITY



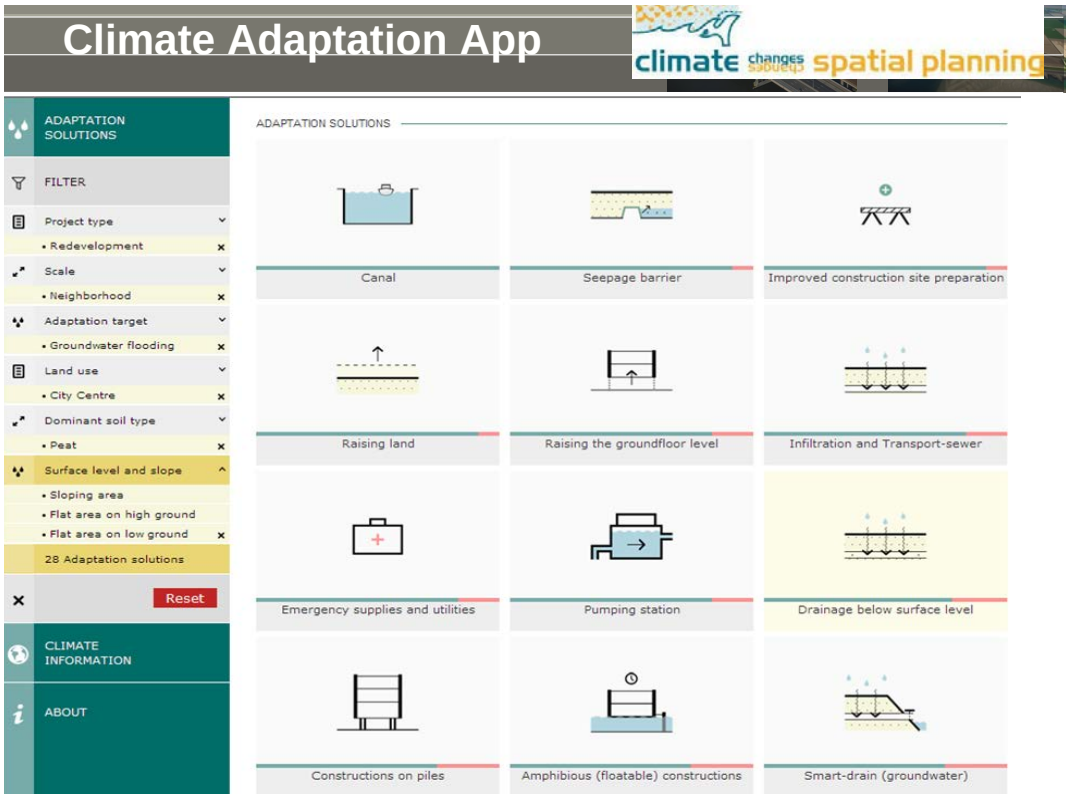
Brown et al 2008. Transitioning to Water Sensitive Cities

the rotterdam water plaza designed by de urbanisten serves as an example for an urban public space that also is a water management infrastructure

One important reason for the involvement of De Urbanisten is that their water plaza in Rotterdam, the Netherlands, addresses a series of relevant problems that CDMX encounters daily. Moreover, it offers a small scale solution that shows the direction in which large scale problems can be solved and added value in the public domain is being created. Or as AEP states: “the proposal is merely a source of inspiration and a precedent to demonstrate that it is possible to deploy strategies of resilience through water-related public space. Furthermore the right placing of this project would convey a powerful message of political will of wealth redistribution in our city.”

The intervention of the water plaza offers space for the immediate and temporal storage of intense rain fall, thus preventing other more vulnerable areas to flood. The technical design allows the water to flow back into ground water and open water bodies, instead of being directed into the combined sewers, thus keeping ground water balanced and preventing local droughts. The aesthetic design allows urban folk to play and linger in this storage space when it is dry, which is the majority of time. Its shapes are designed for social interaction, the planting is designed to create pleasant sub-spaces. The functional design of water elements is aimed at showcasing functional aspects like water drainage in an aesthetic and educational manner. The social design has offered the local community the opportunity to become part of the design process, providing the community with the desired program and atmosphere. And after the realization of the water square, the entire surrounding city quarter is gradually being transformed into a water sensitive neighborhood. Here public space intervention and sewerage replacement are being executed in a refined balance maximizing the closing of local water cycles and optimizing two flows of public money into one integral investment.

THE DELTARES CLIMATE ADAPTATION APP SERVES AS A BASIS FOR A CATALOGUE OF WATER SENSITIVE MEASURES



We believe that many of the aspects mentioned could be appropriate in CDMX: the immediate temporary storage of excess rain water, the social function the water plaza has and the possibility to apply a stepwise transformation of the entire sewage system into a more sustainable one. At the same time the differences will be significant. CDMX has completely different conditions concerning: geology, topography, climate, social setting and overall size to name but a few, compared to Rotterdam and the Netherlands. Therefore it is necessary to understand the differences in context in order to be able to explore the successful water plaza concept as a promising opportunity for a water sensitive CDMX.

The experts of Deltares, the leading Dutch s knowledge Institute on matters of hydrology and geology are the most appropriate engineers to collaborate with in this task. Their global expertise on soil and water management conditions have been vital in making quick estimations on the effectiveness of design concepts during the workshop. The catalogue of water sensitive possibilities (chapter five) has been based on the “Climate adaptation app” developed by Deltares. This toolbox of measures has been weighed in relation to its applicability to the Mexican situation. During the workshop these measures have been selected, altered, adjusted and complemented by the workshop team. The workshop results have been elaborated by De Urbanisten for the situation in CDMX and can be found in one matrix in chapter five.

The overall motto to which the matrix of water sensitive measures is giving substance is: “Delay, retain, store and reuse, only drain when necessary”. This motto is defining goals to be achieved in order to close the water cycle and to create a sustainable water balance on the long term.

DELAY **RETAIN** **STORE** **REUSE**

THE OVERALL MOTTO OF A WATER SENSITIVE APPROACH

DRAIN ONLY WHEN NECCESARY

Water sensitive workshop in Mexico City

On February 2 - 5, an interdisciplinary workshop has been conducted at the location of the Autoridad del Espacio Publico (AEP) in Mexico City. This workshop forms the foundation of content on which the extended advice that can be found in this report has been based. The workshop has been carefully prepared by AEP (Víctor Rico Espínola), De Urbanisten (Eduardo Marin, Florian Boer) and Deltares (Bas van de Pas, Hans Gehrels). The workshop consisted of a four day gathering in which knowledge, inspiration and solutions have been shared. The four days were structured as follows:

Day 1

First day of exchange, with active participation of the AEP-team with its director, the 100 RC-team with its director, the Dutch Embassy with its deputy ambassador , the UNAM-team with professor Loreta Castro and SACMEX as auditorial participant.

On this first day presentations by AEP, UNAM, 100RC, Deltares and De Urbanisten were shared. The discussion within the group addressed the paradigm shift that is needed to go from technical problem solving solutions to multi-purpose water sensitive strategies. The best way to achieve such shifts seems to implement ideas into concrete projects and by doing so an incremental change of practice could take place. This is also a strategic consideration because within given political time frames, it is not effective to try and change a complete policy context first and only then start implemention. “The road has to be changed by walking it”, so to speak. To start this process, the exploration of a catalogue of possibilities for a water sensitive CDMX seemed a good goal to aim at presenting by the end of the workshop week.

Day 2 + 3

Second and third day of fieldtrips in the morning and discussion/sketching sessions in the afternoon. Here the initial concept has been formed by De Urbanisten and Deltares with active constructive and critical participation by AEP (Víctor Rico Espínola) and 100RC (Adriana Chavez).

These days have been focused on research by design: An overall conceptualization of water management solutions for CDMX as a whole; How public space design can effectively contribute to solving storm water problems based on a logical spatial zonation of the city. In the workshop a variety of ways are studied in which storm water can be captured, temporarily buffered and stored long term. How to effectively reuse the scarce fresh water is a crucial issue in CDMX. The main problems are identified per location in relation to its hydrological, social and urban context. The solutions are labeled as conceptual directions in the motto: “Delay, retain, store and reuse, only drain when necessary”. This forms the leading device for a specific set of measures that can be applied to different public space typologies.

The diversity of public spaces that have been visited in these two days reflect the diversity of spaces AEP will be faced with transforming in the coming years. They include: primary streets, intersections, median spaces, plazas, urban public gardens and pocket parks (temporal interventions). To these six typologies - as suggested by AEP - we decide to add the typology of the urban wasteland.

Day 4

The fourth day was a day of intense production by the Dutch team to produce a coherent, comprehensive story of professional findings to the same broad audience that has participated on the first day. In a lively group discussion the results were reinforced concerning their headlines and enriched with valuable comments and suggestions. Added remarks in the discussion included:

- Can indicators be identified as to when and where, which specific water sensitive measure is most appropriate?
- A more precise solution to primary roads or urban highways is desirable, specifically in relation to conflicting claims for space.
- A more precise insight on ground water balance is needed and could be integrated into the overall conceptual story,
- A general indication of cost-benefits of different measures would be desirable,
- An insight in possible added values of 'ecosystem services' in relation to the measures presented would be interesting,
- Health and maintenance issues should be identified
- Aspects of governance and social responsibility should be identified

The given remarks will be taken into account and elaborated in the report, as much as possible and as far as it can fit within the given (and limited) assignment.

IMPRESSION WORKSHOP DAYS

SLOPE
R+S
VALLEY
R+T
MOUNTAIN
R+ST

Report reading guide

The results of the workshop days have been transcribed, upgraded and elaborated into this report document. This document emphasizes visual material showing maps, diagrams, sections and photos conducting a storyline in which textual explanations support this narrative that predominantly consists of visual information and ideas. This narrative consists of the following six items:

The story of the lake

The report starts with a brief outline of the history of the region of Mexico City and provides this study with the necessary context to understand its current situation and the problems it faces. This overview takes giant steps through history to emphasize the landmarks in time that have been relevant to the current water challenges the city is facing.

The spatial hydrological cycle of the valley

To understand the water challenges the city is facing we present a brief but comprehensive analysis of the physical situation of Mexico City including aspects like geomorphology, hydrology, subsidence, sewer networks, aquifer exploitation and climate conditions. In a series of specially designed maps the main problems are outlined in an insightful way, supported by diagrams and photographs. They explain the challenge to be tackled in Mexico City.

Building up a water sensitive Mexico City

In this chapter zoning the public domain of Mexico City is deployed as an overall water management strategy by the motto: “Delay, retain, store and reuse, drain only when necessary”. This includes a definition of the ambitions concerning water management and public space and a conceptual proposal for a water sensitive Mexico City. It results in a “Water sensitive zoning map” and the main goals per zone subdividing the entire territory of the Federal District of Mexico City.

A catalogue of water sensitive possibilities

Related to the motto defining subsequent goals: “Delay, retain, store and reuse, drain only when necessary”, a matrix of possible public space measures are defined. This ‘toolbox’ is connected to the water sensitive zoning map of the previous chapter. Per zone a set of appropriate water sensitive measures is illustrated with relevant reference project images.

7+1 Water sensitive public space typologies

In this chapter the measures of the previous chapter are translated into conceptual design typologies onsite in Mexico City. We will focus on areas relevant for AEP-intervention: the Central city and Iztapalapa. On the basis of seven public space typologies, exemplary water sensitive interventions are illustrated in conceptual design proposals. In an descriptive section a combination between smart water management and quality public space fit for active urban use will be shown.

Recommendations

In the last chapter, suggestions for next steps are proposed. Aspects of maintenance, health and governance will be brought to attention, further research questions will be defined and promising next steps will be suggested.

THE STORY OF THE LAKE

UNDERSTANDING THE HISTORICAL CONTEXT

CHAPTER 2

The history of the region of Mexico City provides this study with the necessary context to understand its current situation and the problems it faces. This overview takes giant steps through history to emphasize the landmarks in time that have been relevant to the current water challenges the city is facing. In this chapter we chronologically walk through the historical development of the city from pre-settlement times until urbanization proliferated in the valley and came to constitute the modern metropolis Mexico City is today.

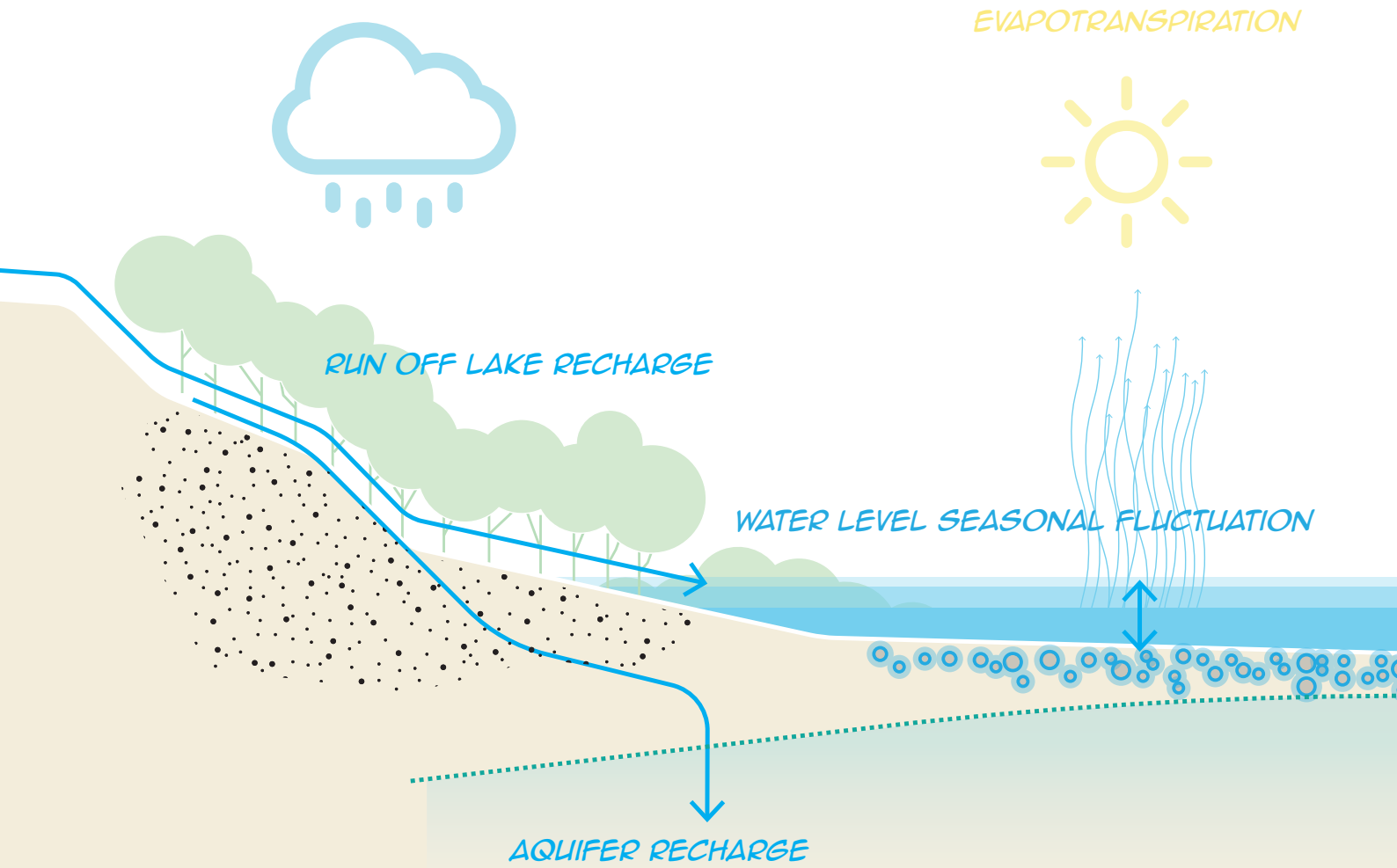
The pristine valley before first settlements started taking place here

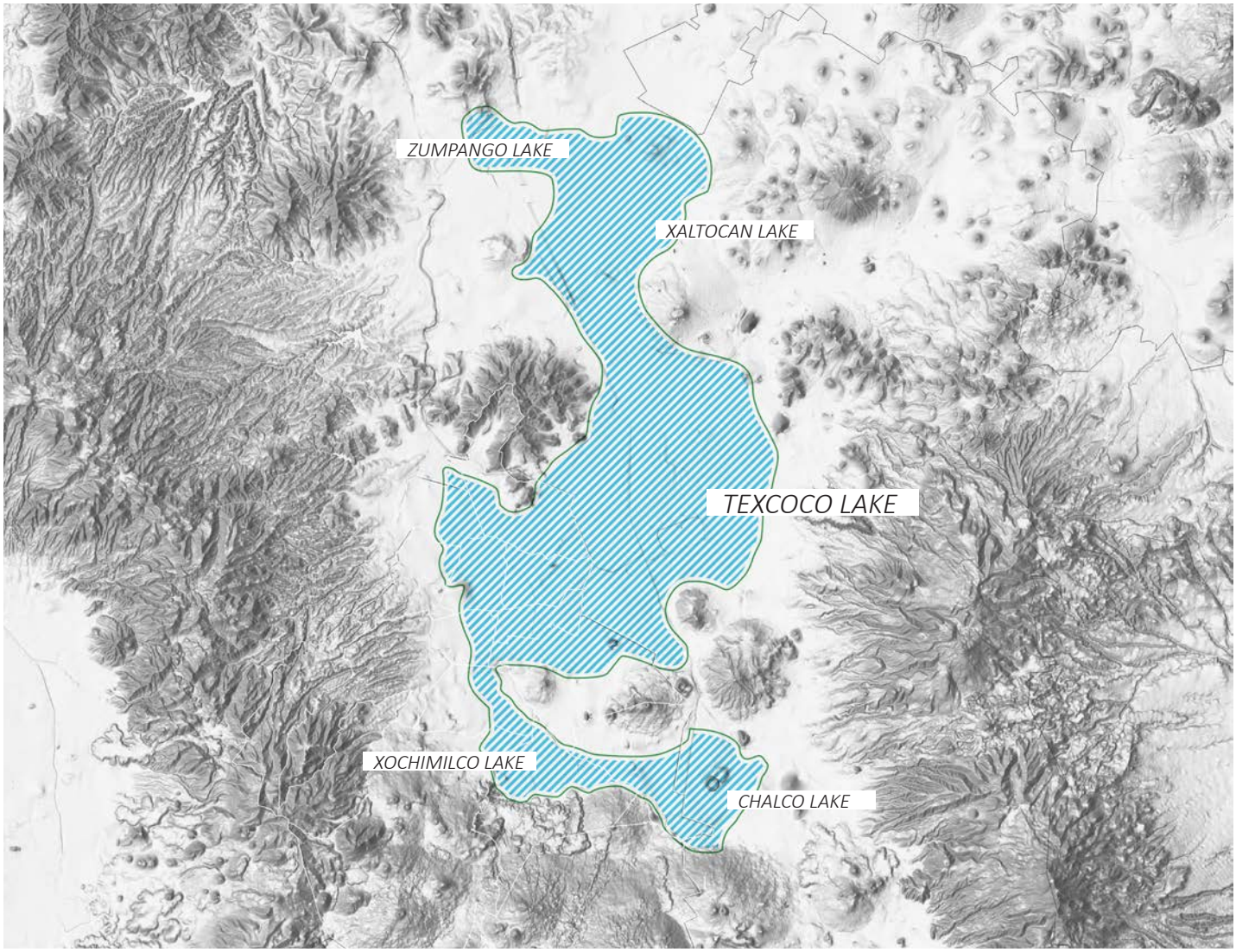
BEFORE SETTLEMENTS

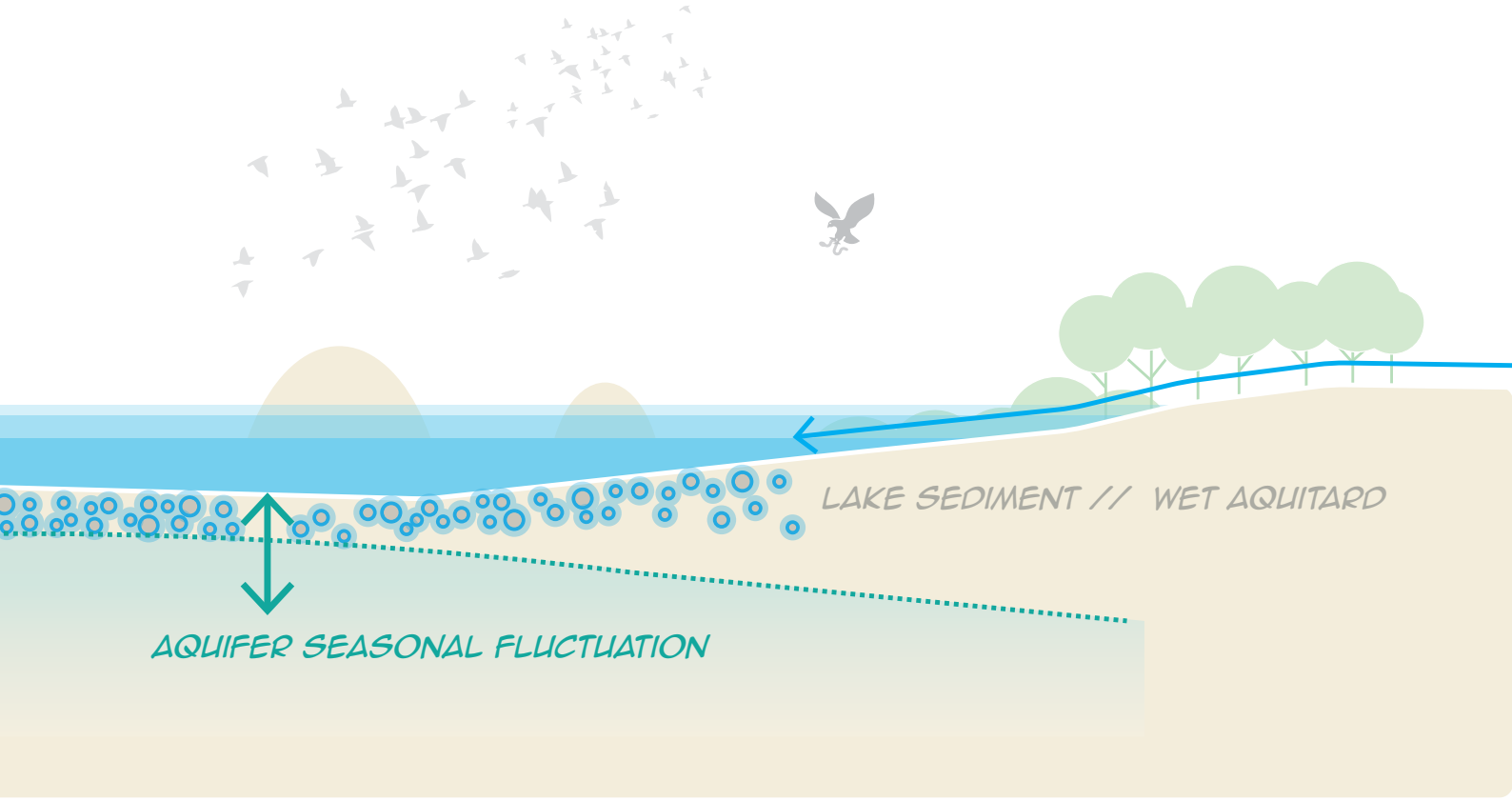
The origin of the Mexico city is intimately linked with water. The territory where we find today one of the largest cities in the world, formerly was an interrelated system of lakes that dominated the plain of the valley from the foot of the Sierra de Chichinautzin until the north zone, with a total surface area of 1,100 square kilometer.

The compositional characteristics of the geology of the Valley of Mexico are important factors in understanding the historical and current relationship the city has with water. It explains the way the basin operates because of its special condition which is quite different compared to other lake systems. The basin of the Valley of Mexico City is an endorheic basin. It is a closed drainage basin that retains water and allows no outflow to other external bodies of water, such as rivers. It collects all the water from its watershed and stores the water from rain and streams that run down the surrounding mountains, and then very slowly infiltrate into the ground due to a thick layer of impervious sediment called the “aquitard”.

THE ORIGINAL SITUATION OF THE VALLEY AND ENDORHEIC LAKE




ZUMPANGO LAKE
XALTOCAN LAKE
TEXCOCO LAKE
XOCHIMILCO LAKE
CHALCO LAKE


LAKE SEDIMENT // WET AQUITARD
AQUIFER SEASONAL FLUCTUATION

AZTEC TIMES

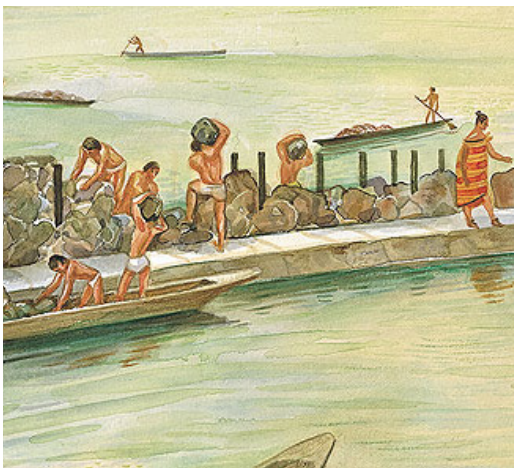
THE LAKE CITY: TENOCHTITLAN

source : MURAL BY DIEGO RIVERA SHOWING THE LIFE IN AZTEC TIMES.

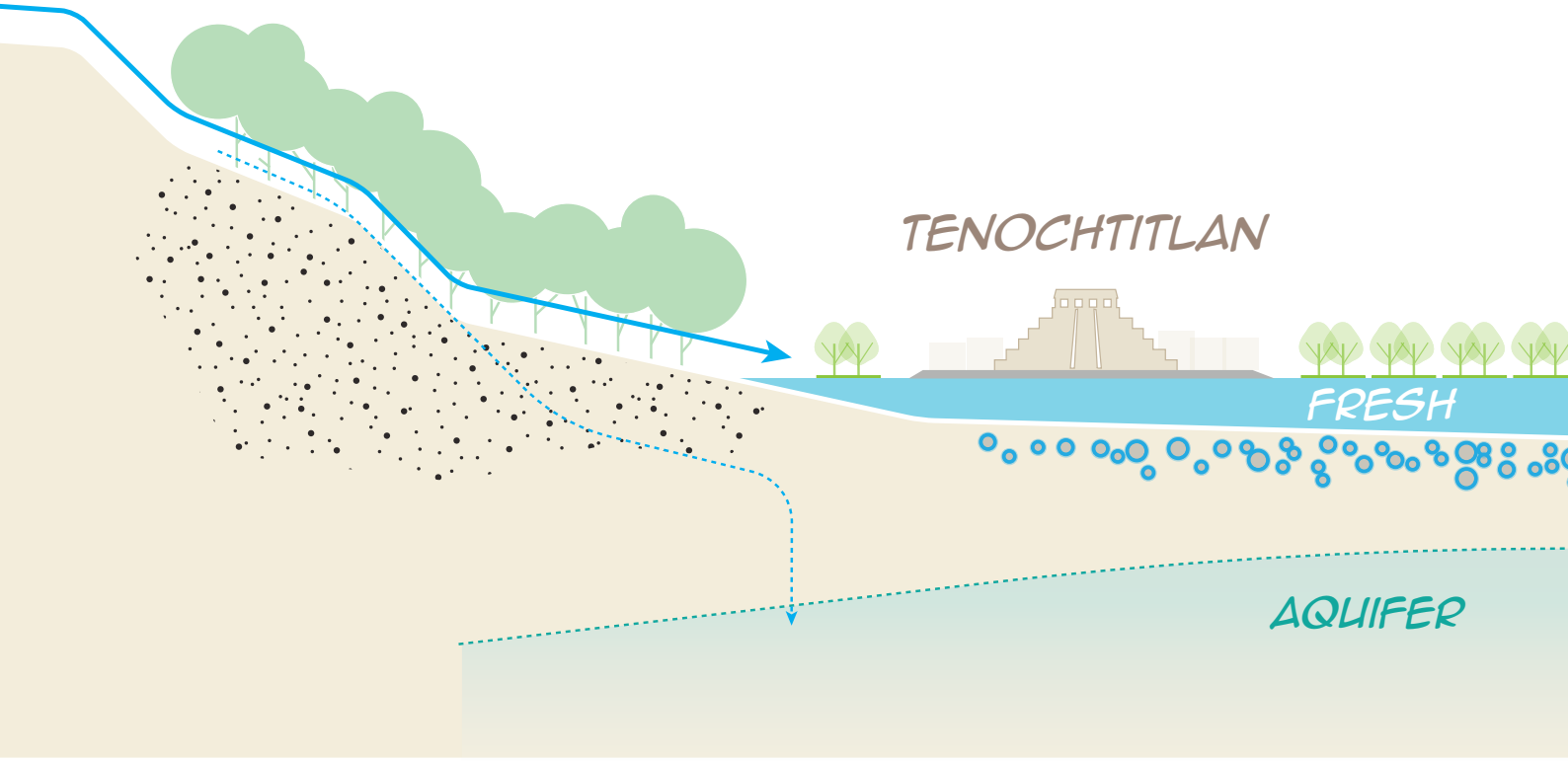
AZTEC TIMES
THE LAKE CITY: TENOCHTITLAN

According to Mexican mythology, the deity Azteca Huitzilopochtli ordered his people to establish his kingdom where they would find “An eagle perched on a cactus devouring a snake”. Although there is a lot of mythology and legend surrounding the origin of the city of Tenochtitlan, historical evidences indicate that the capital of the Aztec empire was originally installed on a small island on the lakes of the Valley of Mexico. This position, surrounded by lakes with rising water levels in the rainy season which partly flooded their island forced them to develop a deep knowledge of the ways of the water in order to survive. The first works of hydrological engineering date from this time. An elaborate system of dams or ‘albarradones’ divided the eastern brackish waters from the western fresh waters and was used to control the water level of the lakes. Another example that illustrates the advanced level of knowledge of the Aztec people in relation with the lakes, was the system of agricultural cultivation called ‘Chinampa’,which was based on expanding the arable land on the lake surface by using an ingenious system of soil filling.

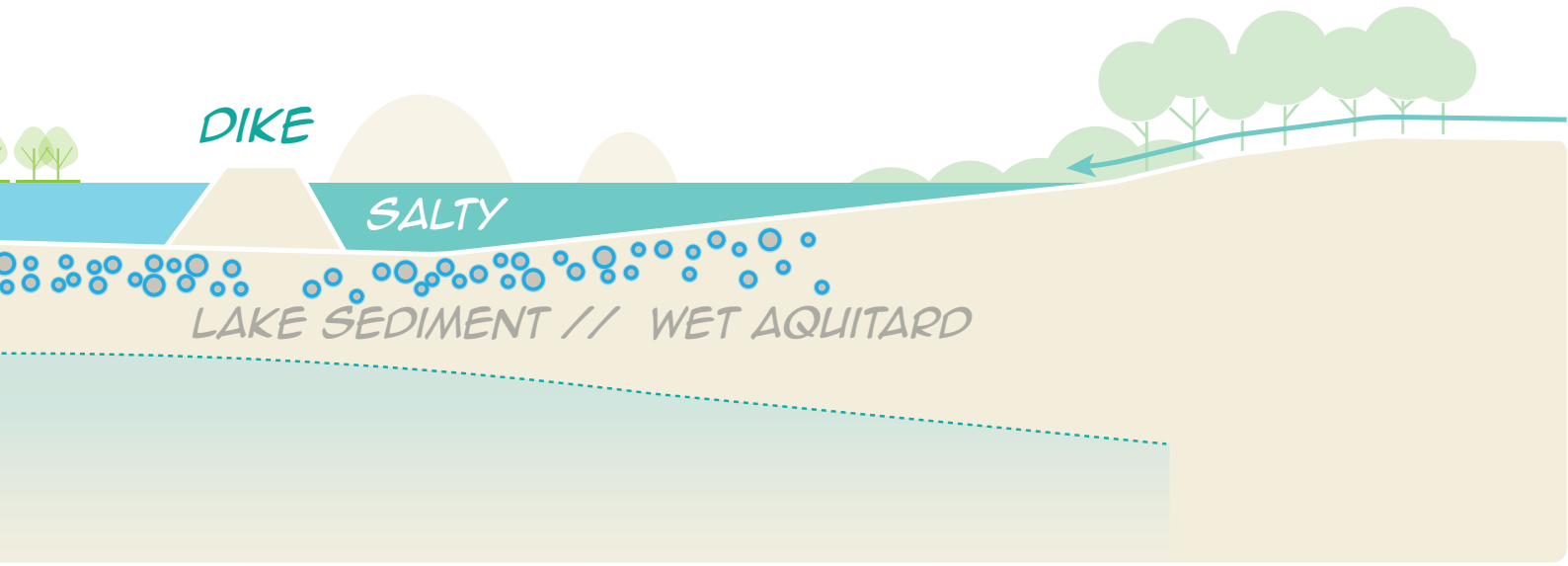
Chinampas



Albarrada de Nezahualcóyotl



source : national museum of anthropology



COLONIAL TIMES

THE BEGINNING OF THE DRAINING OF THE LAKE

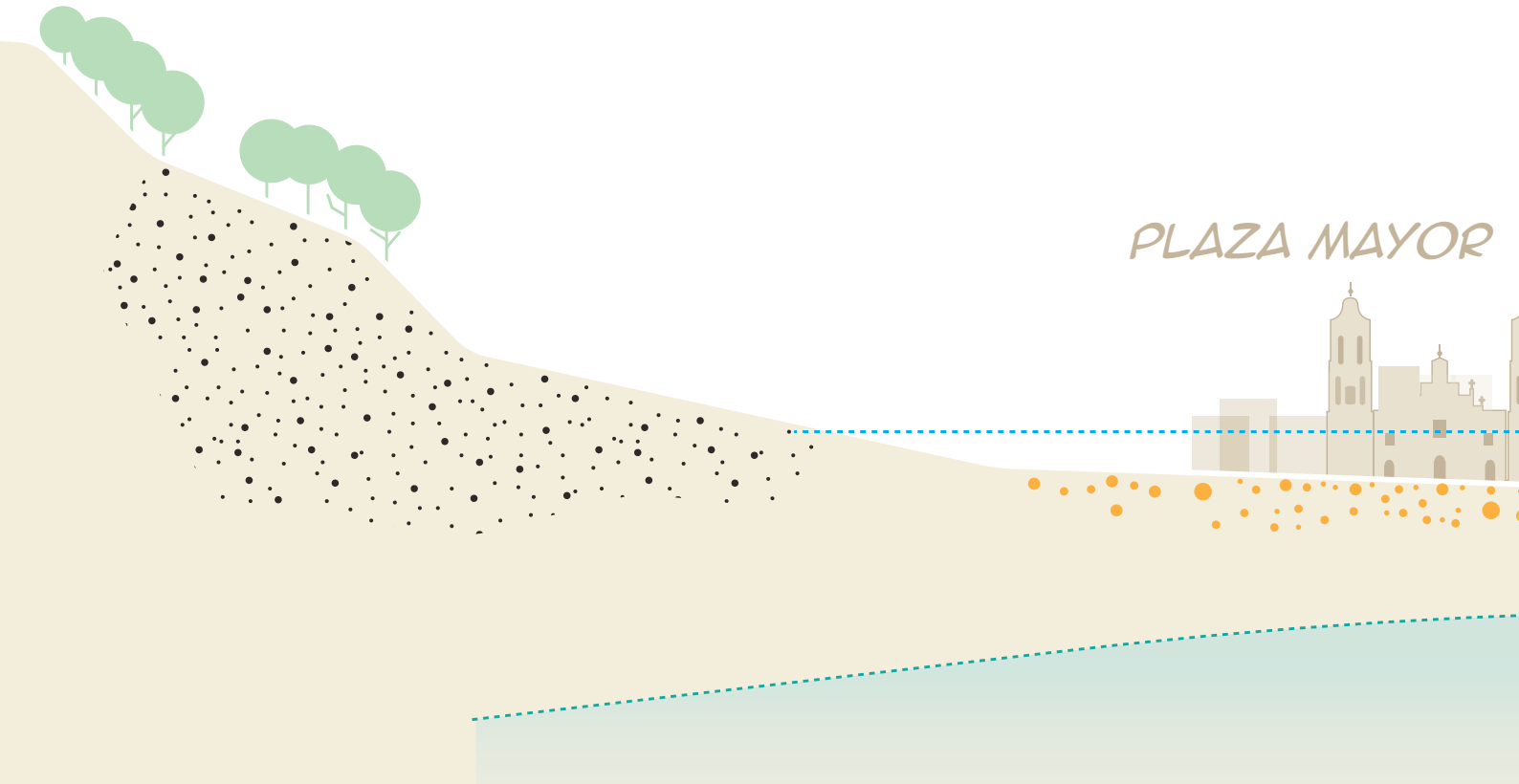
visit of the viceroy francisco fernández de la cueva al pueblo de ixtaclco, 1634.

source : PICTURE BY PEDRO DE VILLEGAS

COLONIAL TIMES
THE BEGINNING OF THE DRAINING OF THE LAKE

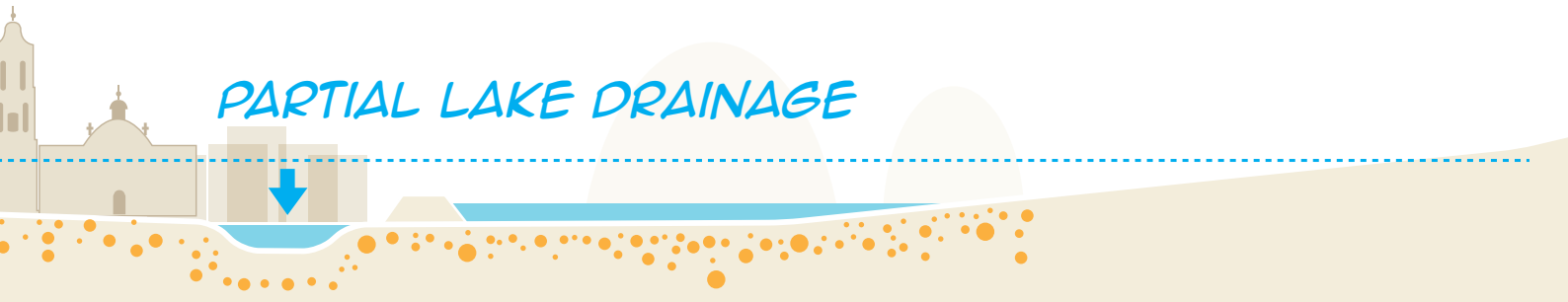
Toward the middle of the fifteenth century, when America had been 'discovered' by the Spanish, the Aztec civilization was colonized by the Spanish Crown. When Hernán Cortés arrived to the valley of Mexico he encountered on the lake the great city of Tenochtitlan with an estimated population of 175,000 inhabitants. It had an elaborate urban structure, a large central square surrounded by alleys and channels. One of the key factors for the establishment of the Spanish domain though, was to create a new city model similar to the Renaissance city that had been developed in Europe. During its construction, the new city entered into conflict on successive occasions with strong periods of flooding from the lake that hindered and delayed the works. After the floods of 1604 and 1607, and to eradicate the natural threat, they decided to build the canals of Huehuetoca and Tajo de Nochistongo to create the first artificial outlet for water from the basin of Mexico. This was the start of the lake drainage.

Image of the Tajo de Nochitongo in the deeper area.



Map of mexico from 1778.

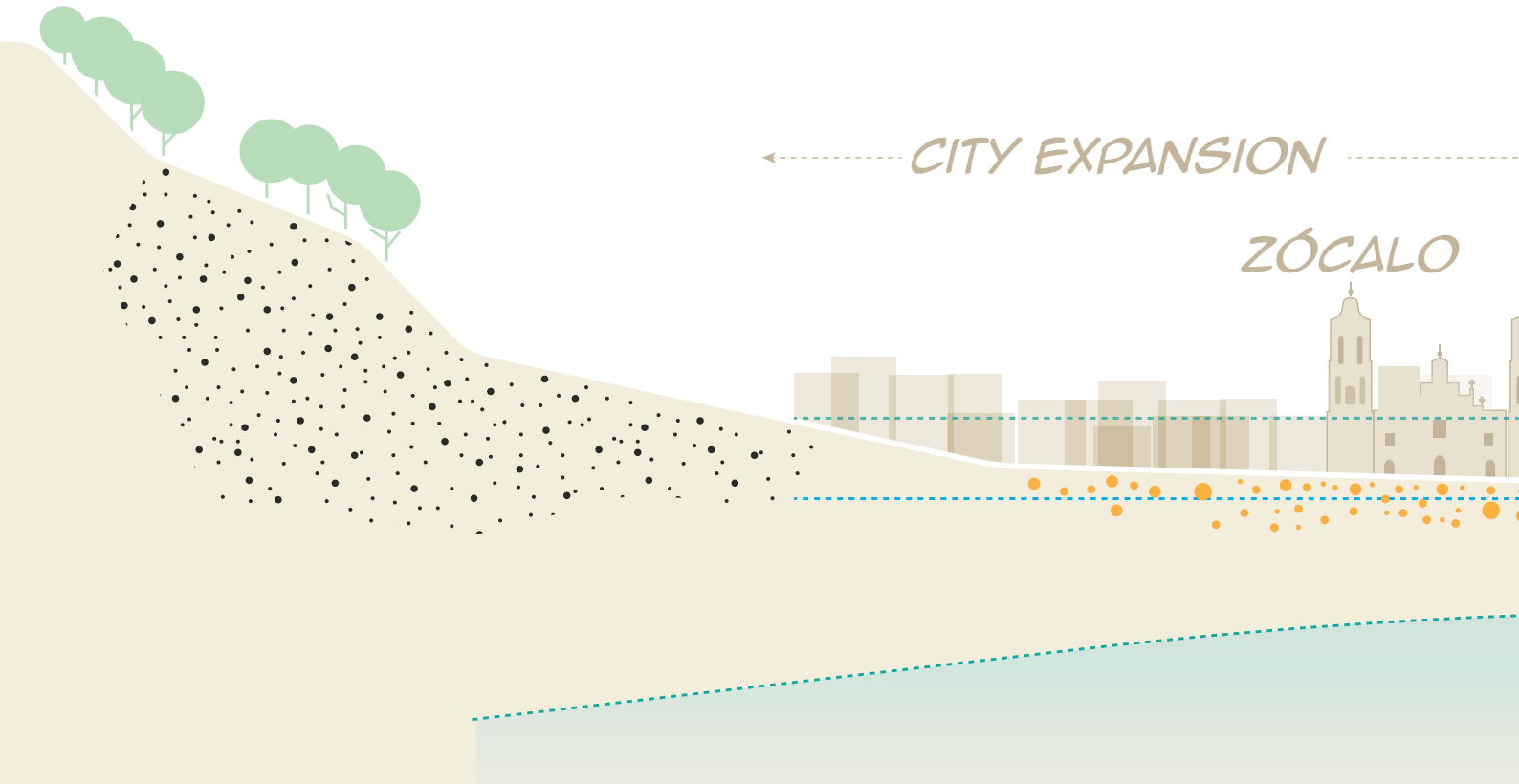
PARTIAL LAKE DRAINAGE



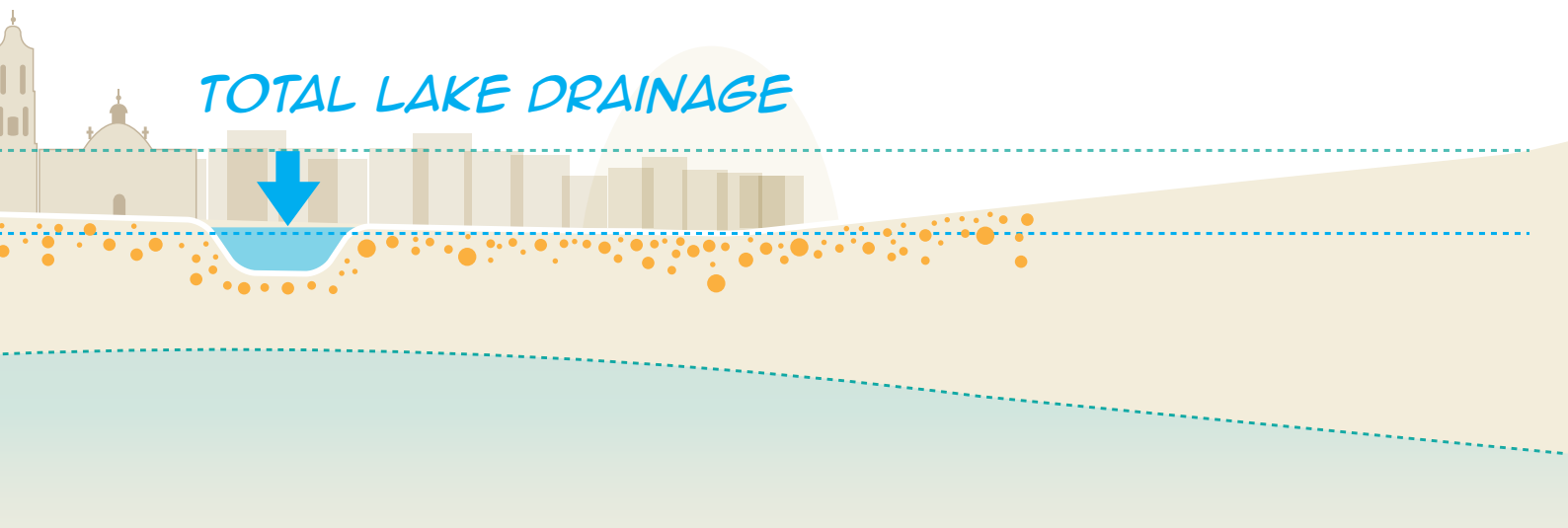
MEXICAN TIMES
THE CONTINUATION OF LAKE DRAINAGE AND CITY EXPANSION

After colonial times the establishment of the Mexican capital, was marked by the continuation of construction of big canals and drainage infrastructure to transport the water artificially to the next watershed. During the nineteenth century, after liberation from the Spanish conquerors, the construction of the 'Gran Canal de Drenaje' was one of the most important engineering works under the Porfirio Diaz administration. The draining of the lake has been consequently continued until today, reducing the surface of the lake dramatically and confining it to small sheets of water sprinkled through the valley of Mexico City.

General Plan of the bureau of the Valley of Mexico with indication of drainage channels, navigation and irrigation planned by the engineer Francisco de Garay (1856). Old image of the gran canal construction.



source : Birds-eye view of Mexico city by Dusacq ciu. cica



MODERN TIMES

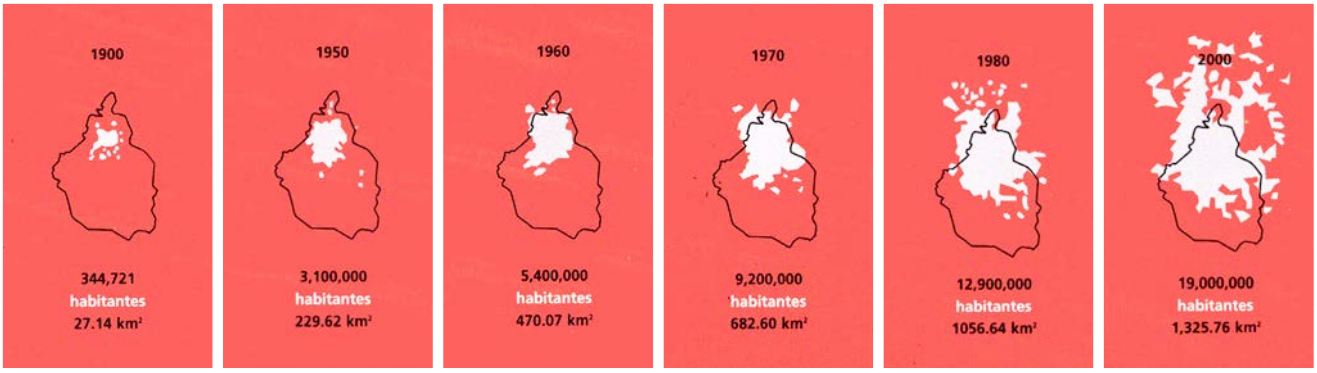
THE ENDLESS METROPOLIS

The urbanisation of Mexico City reaches beyond the horizon

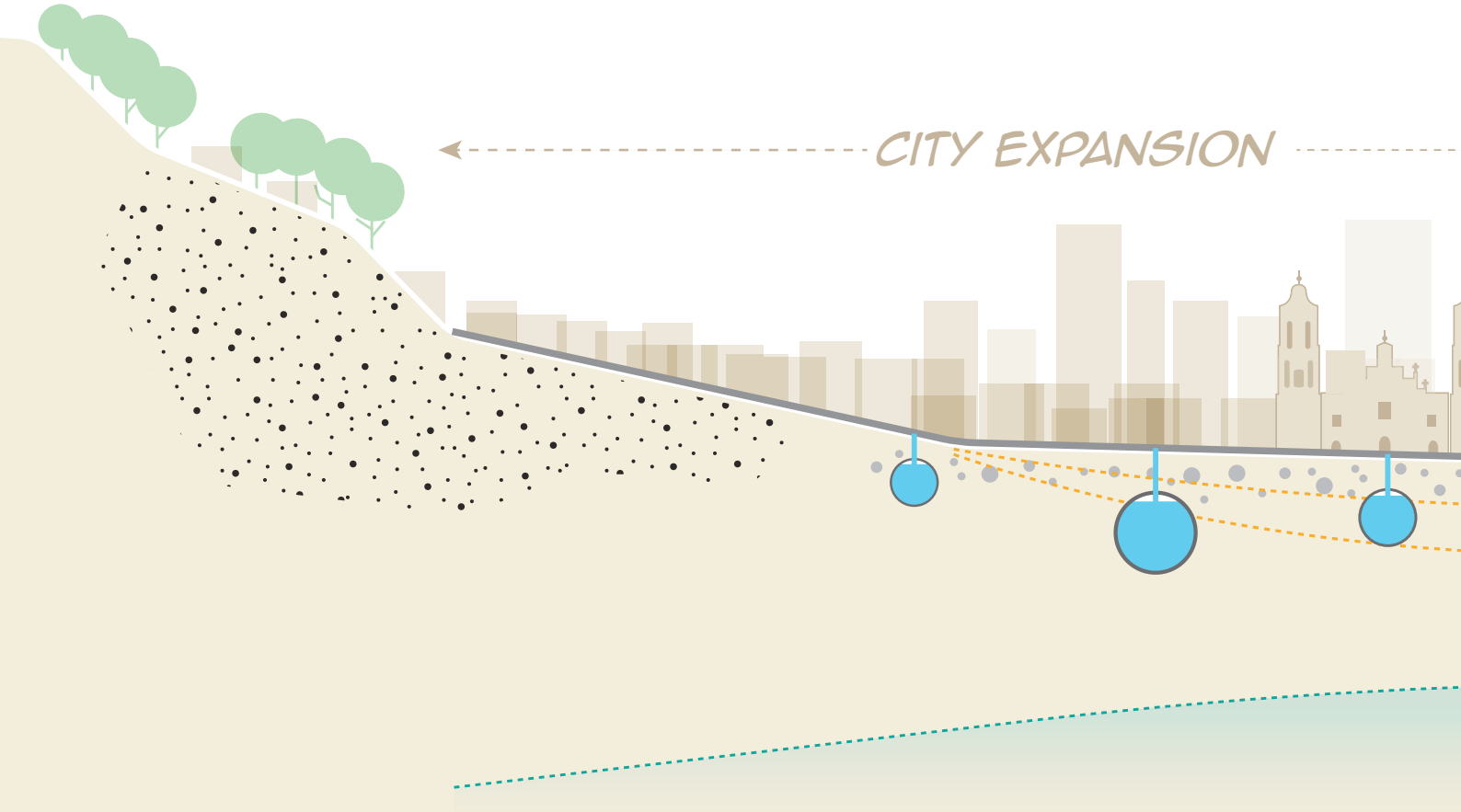
COLEGIO Del Valle

MODERN TIMES
THE ENDLESS METROPOLIS

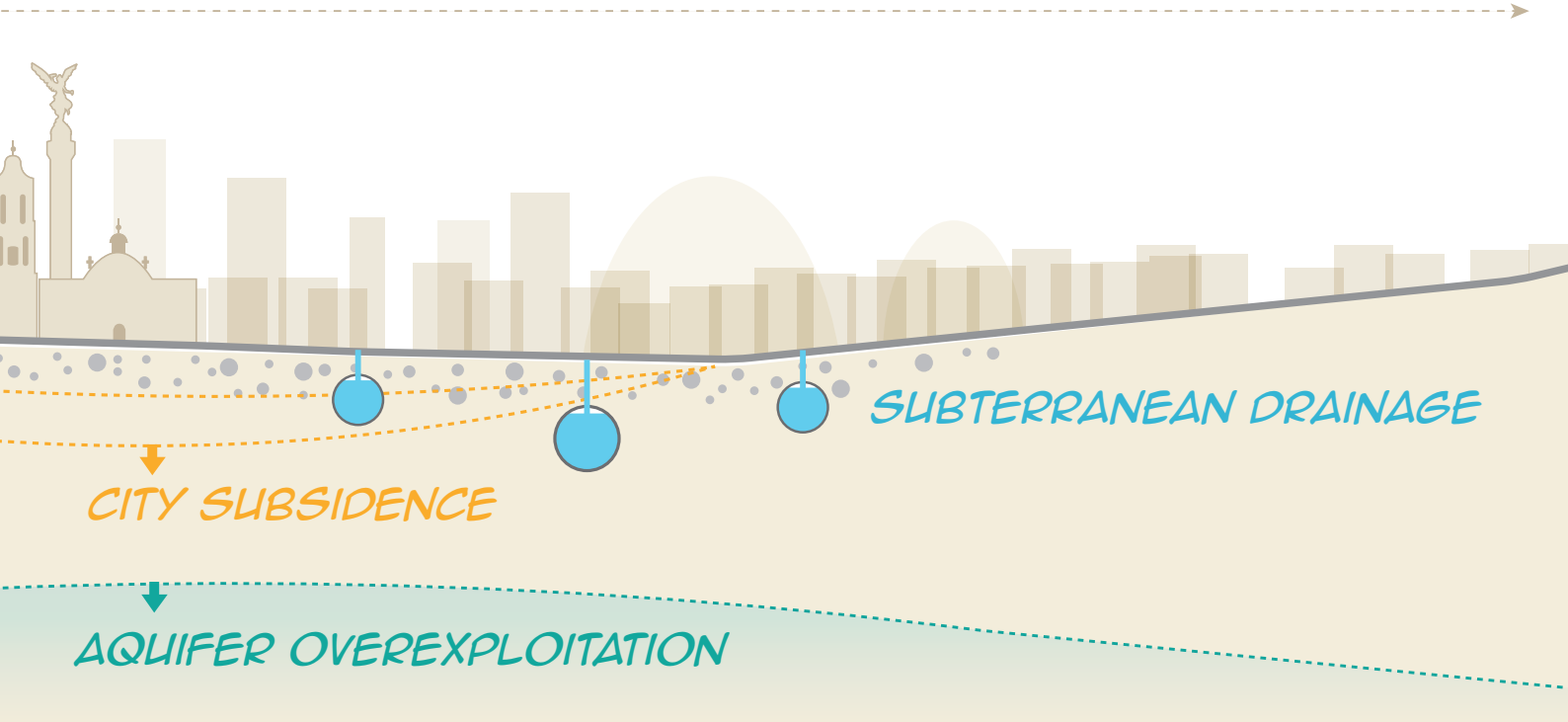
Since the nineteenth century Mexico City has been expanding at a fast pace. The introduction of the steam railroad and tramway lines facilitated a substantial growth like many other main cities in America and Europe have seen. Especially in the fifties, sixties and seventies of the 20th century the city expanded even more thanks to the introduction of large arterial road infrastructures and the introduction of the metro system. By the end of the seventies, Mexico City had over 9 million inhabitants. Today Mexico City is one of the largest metropolises in the world. With a population of more than 22 million inhabitants the urbanized territory is beyond imagination and extremely difficult to serve in appropriate mobility and water infrastructure.



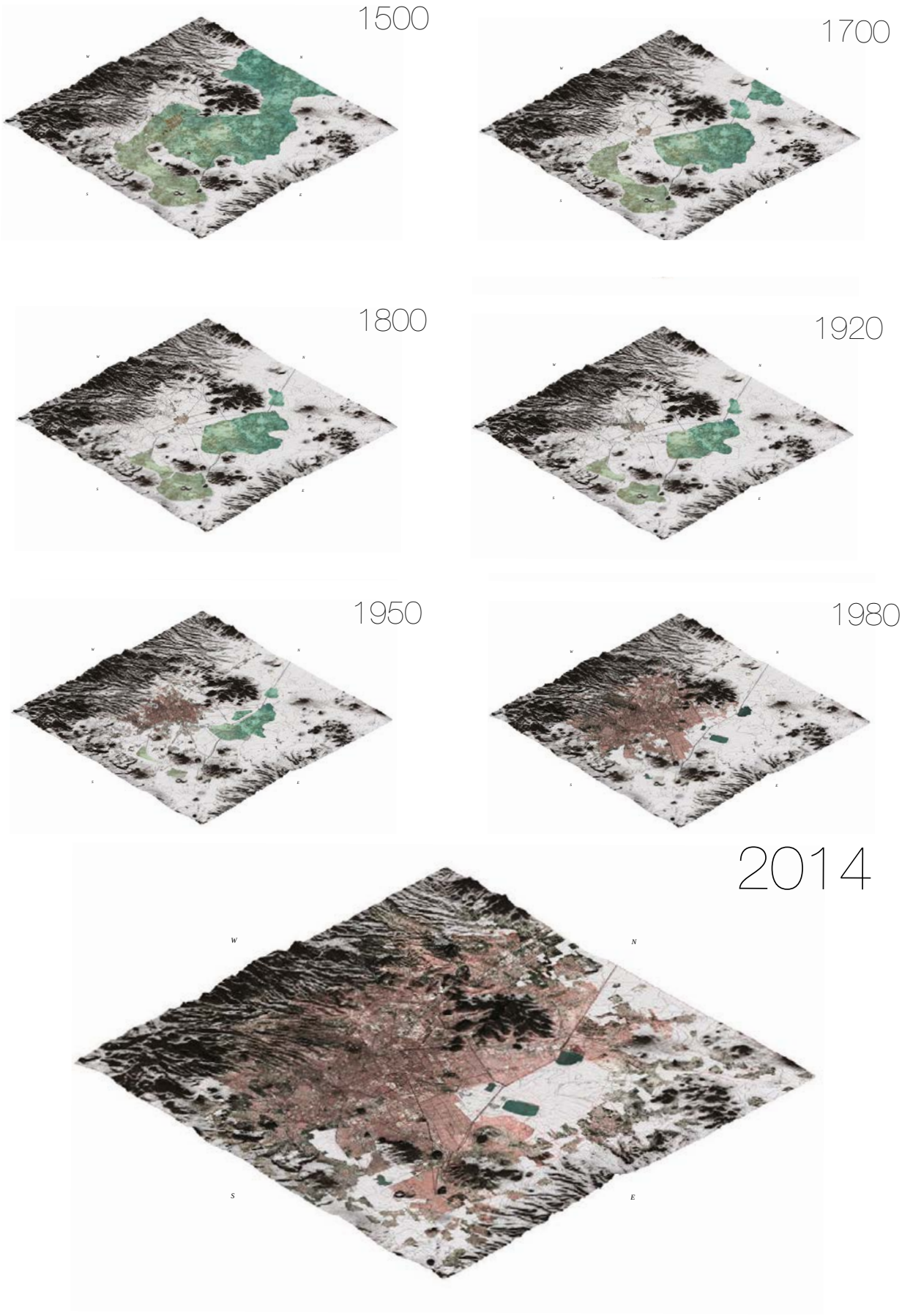
Expansion of the urban sprawl of Mexico City



1952 flood of the centre of Mexico City



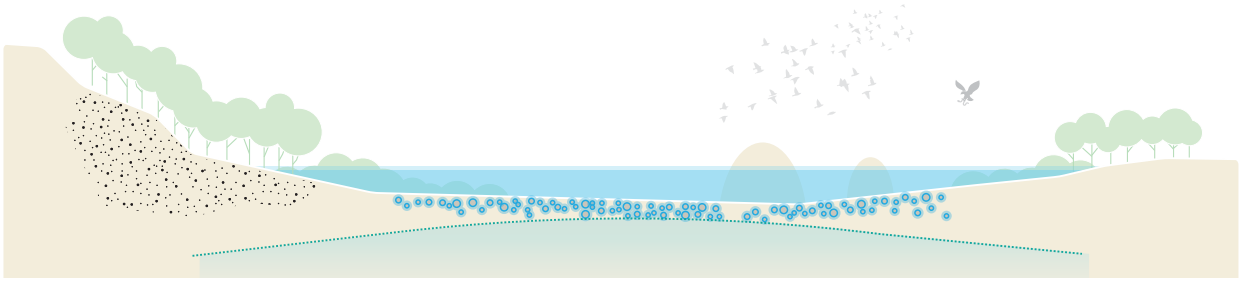
TIME SEQUENCE OF LAKE-VALLEY DRAINAGE



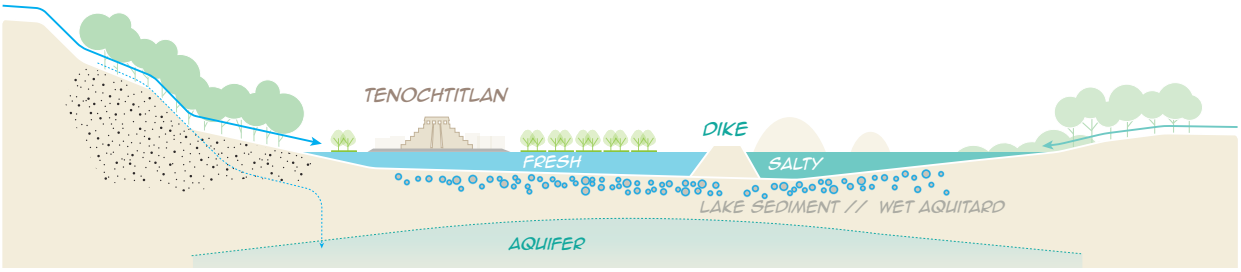
source : Victor Manuel Rico Espínola_ Fall 2013 Harvard University Graduate School of Design

Aerial view of El gran canal de drenaje

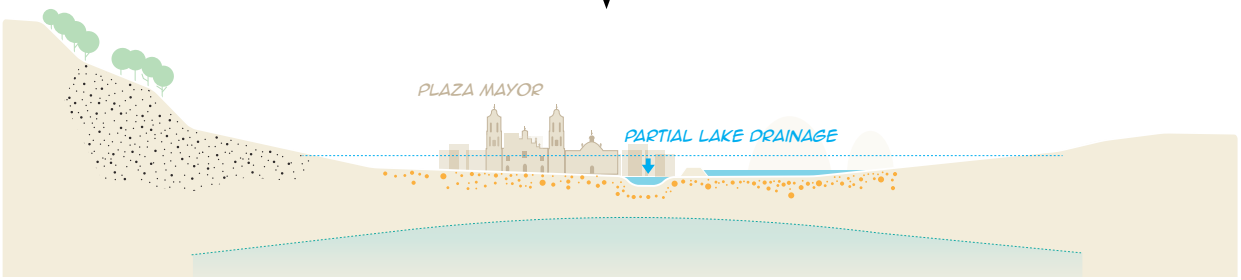
SEQUENCE OF THE LAKE-CITY RELATIONSHIP



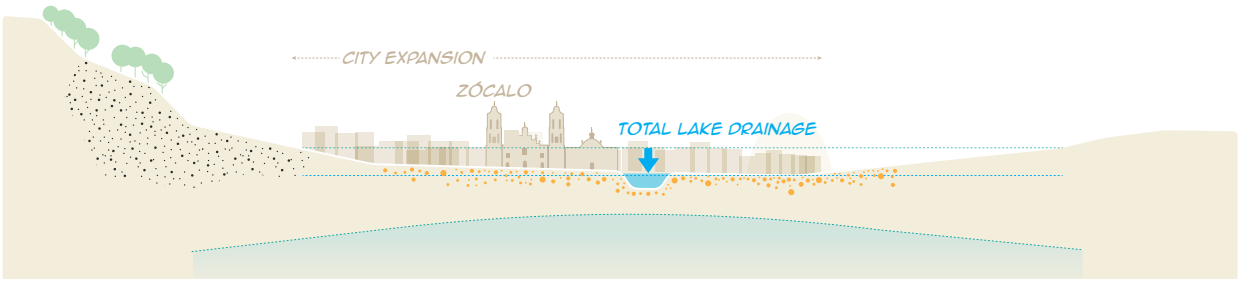
BEFORE SETTLEMENTS



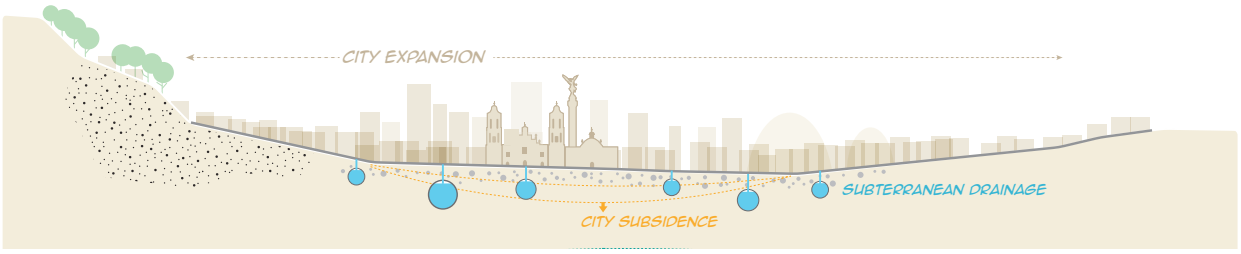
AZTEC TIMES



COLONIAL TIMES



MEXICAN TIMES



MODERN TIMES

Nowadays the streets of Mexico City regularily flood in the rainy season

THE SPATIAL HYDROLOGICAL CYCLE OF THE VALLEY

ANALYSIS OF THE CURRENT SITUATION

CHAPTER 3

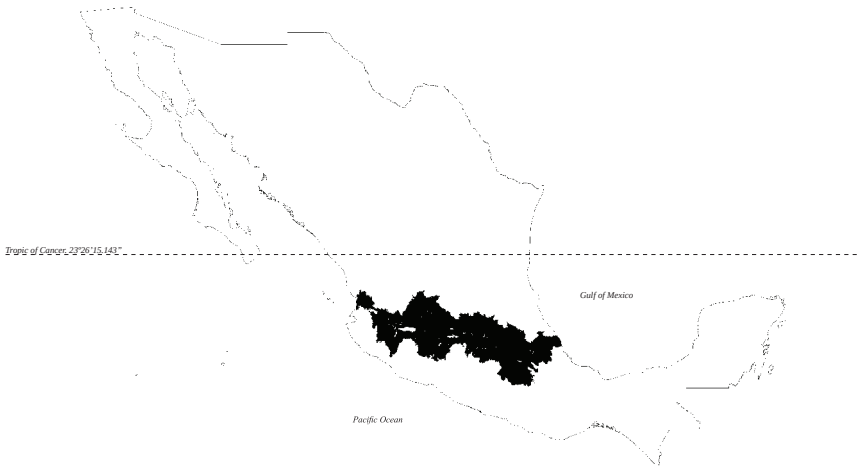
The delicate geographical position on an endorheic lake bed combined with the urban and social pressures of one of the largest metropolitan cities in the world, has created an extremely complex hydrological situation which has inevitably severely disturbed the original water cycle.

To understand the water challenges the city is facing we present a brief but comprehensive analysis of the physical situation of CDMX. In a series of specially designed thematic maps and diagrams the main problems are outlined in an insightful way. These maps follow the path of the water from where it falls as rain until it is drained out of the valley and traces the consequences this drainage has for the valley. The analysis covers the general variables such as topography, geology and climate conditions, as well as the variables of the hydrological cycle that pose a risk to the population due to the irreversible changes that they are causing .The analysis explains the challenge to be tackled in a water sensitive CDMX.

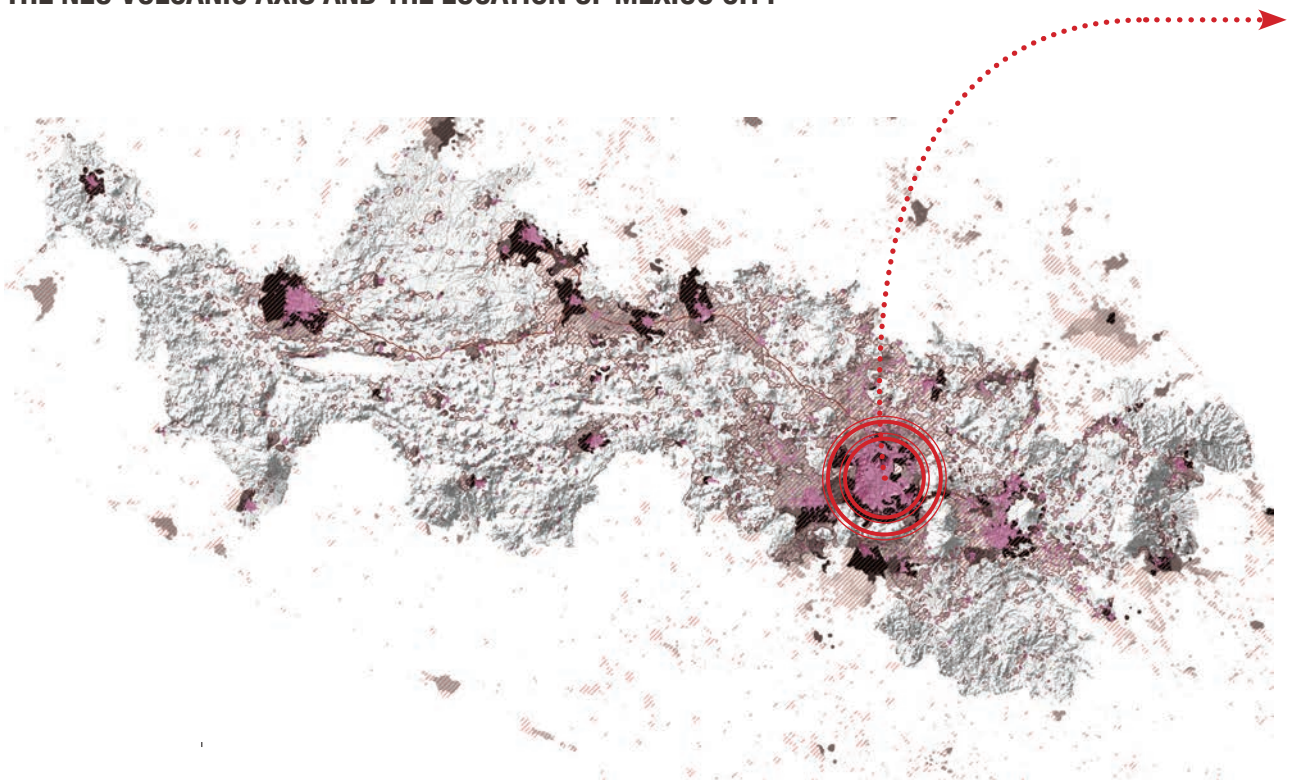
The current urbanisation pattern of the mountains does not allow any rain to infiltrate. On the contrary, it helps to accelerate the water dramatically. Photograph by Iwan Baan

HYDROLOGICAL MODEL OF MEXICO VALLEY
TOPOGRAPHICAL CONDITION

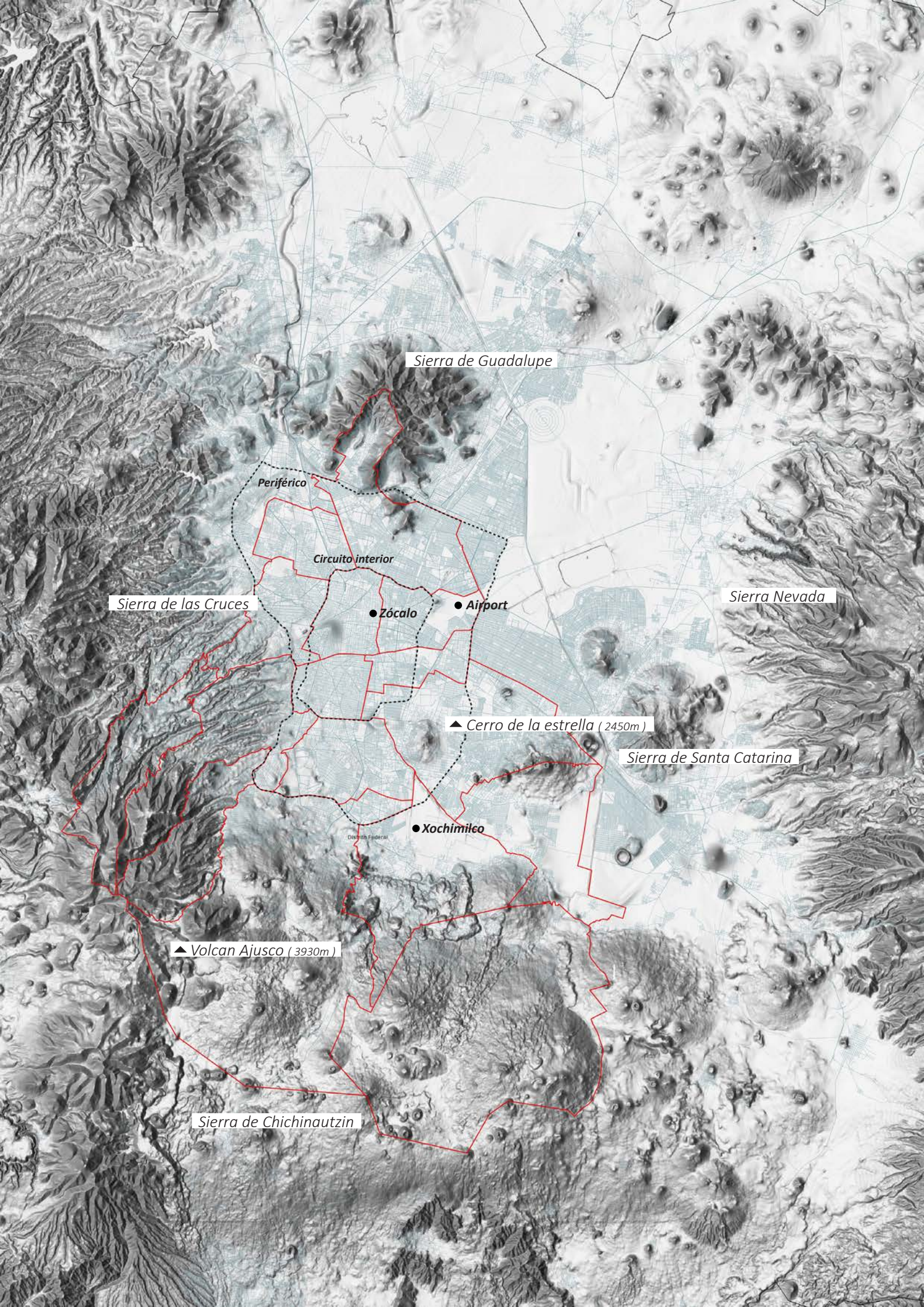
Mexico City is located at an altitude more than 2000 meters above the sea level, in the so-called Neovolcánic axis that crosses the geography of the country from the Pacific Ocean to the Caribbean Sea. The city is located in a landscape formed by a large volcanic mountainous system with steep slopes, and a flat valley bed. Originally a system of lakes was located here which collected the water draining away of the surrounding mountains through streams and small water channels.



THE NEO VOLCANIC AXIS AND THE LOCATION OF MEXICO CITY



source : INSTITUTO NACIONAL DE ESTADÍSTICA Y GEOGRAFÍA MEXICANO
VICTOR MANUEL RICO ESPÍNOLA_ FALL 2013 HARVARD UNIVERSITY GRADUATE SCHOOL OF DESIGN

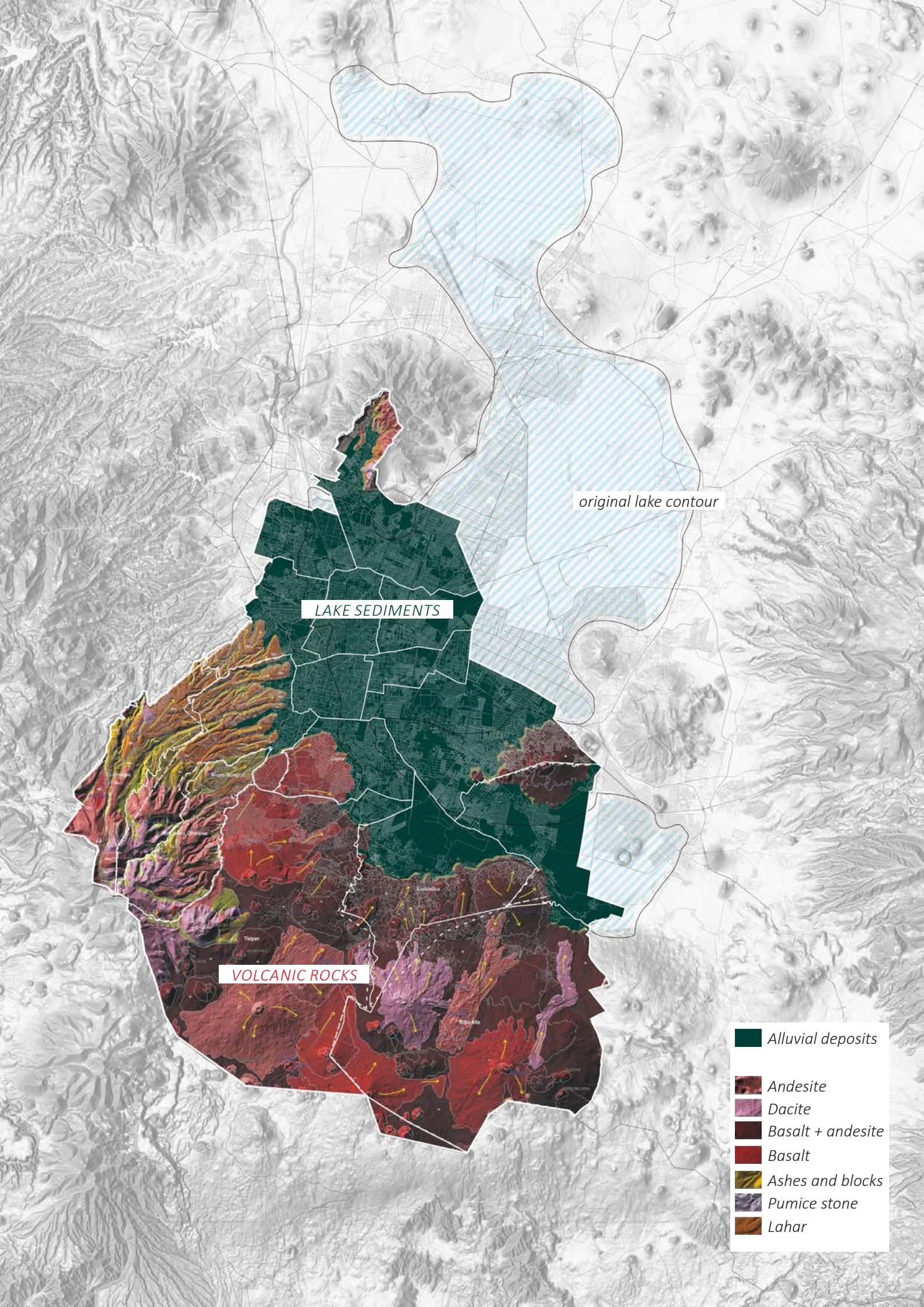

Sierra de Guadalupe
Periférico
Circuito interior
Sierra de las Cruces
Zócalo
Airport
Sierra Nevada
Cerro de la estrella (2450m)
Sierra de Santa Catarina
Xochimilco
Distrito Federal
Volcan Ajusco (3930m)
Sierra de Chichinautzin

HYDROLOGICAL MODEL OF MEXICO VALLEY
GEOLOGY

The geological base of the valley of Mexico City is composed of two entities of a very different nature. First, the mountains, hills and slopes are formed by rocks of volcanic origin like basalts and andesites. On the other hand, the valley is formed by the typical sediments of a lake bed that have been dragged and dropped by the water in the bottom of the valley. These are mostly, clay, silt and sand. The city mainly settled on top of this layer.

THREE EMBLEMATIC SOIL SAMPLES SHOW THE MAIN VARIETY WITHIN THE VALLEY OF MEXICO CITY: VOLCANIC ROCK, LAHAR SLOPES AND LAKE BED SEDIMENTS

source : DIRECCIÓN GENERAL DE PROTECCIÓN CIVIL DEL DISTRITO FEDERAL


original lake contour
LAKE SEDIMENTS
VOLCANIC ROCKS
Alluvial deposits
Andesite
Dacite
Basalt + andesite
Basalt
Ashes and blocks
Pumice stone
Lahar

HYDROLOGICAL MODEL OF MEXICO VALLEY
CLIMATE ZONES AND PRECIPITATION

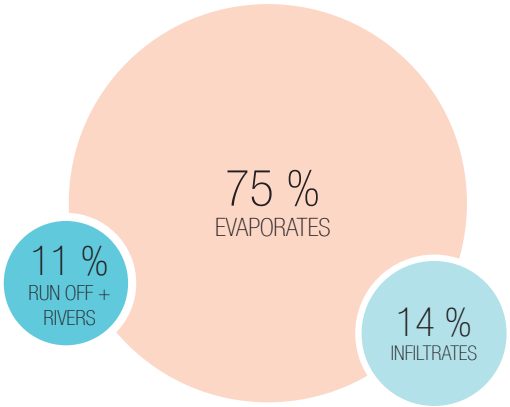
The State of Mexico City has significant differences in altitude ranging from the urbanized valley at approximately 2,250 meters to the surrounding mountain range and volcanos at 3900 meters . Due to this difference the area has different weather conditions ranging from a humid and rainy climate in the mountainous area, to a dry and hot climate in the lower areas of the valley. This gradient gives rise to a great variety of ecosystems and plant associations ranging from humid forests to dry grasslands with saline vegetation.

In the metropolitan area of Mexico City the precipitation varies from 600 to 1,500 millimeters annually. This distribution throughout the year is uneven: almost all rain falls between June and October. There are three ways in which the precipitation continues in the regional water cycle:

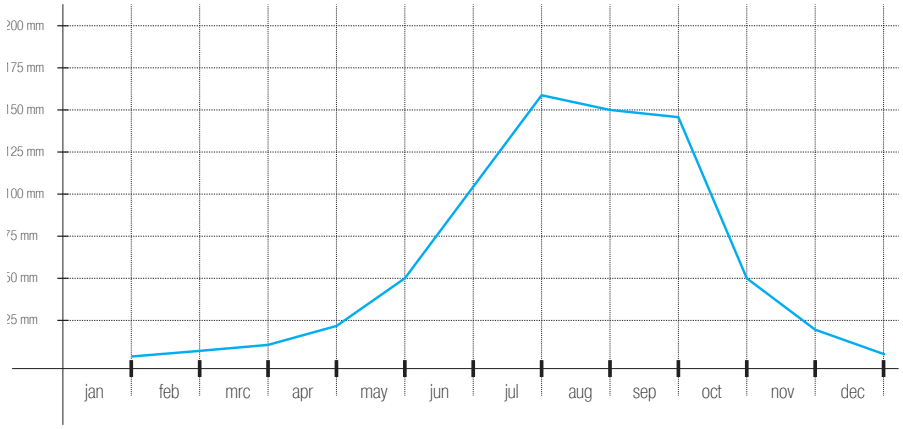
- The rainwater evaporates (on average 75%)
- The rainwater runs off via canals and rivers (on average 11%)
- The rainwater infiltrates in the soil (on average 14%)

These figures are averages for the entire valley of Mexico City. Within the valley there are major differences: In the high mountain area, there is substantially less evaporation and the infiltration and run off rates will be higher; In the west part of the urbanized valley there will be less evaporation and more run off; In the east part of the urbanized valley the evaporation is most dominant and infiltration is very low. These differences will be explored on the next pages.

DESTINATION OF THE RAIN, IN PERCENTAGES, ANNUALLY



DISTRIBUTION OF RAIN OVER THE YEAR *



source : LA FLOR FANERÓGAMICA DEL VALLE MEXICO

** DATA REGISTERED IN TACUBAYA METEREOLOGICAL STATION*

Mild Semi Dry

Xerophilic brushwood

Halophic meadow

Sub Humid with summer rainfall.

Pine forest

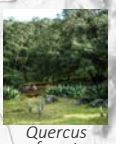
Juniperus forest

Quercus brushwood

Seasonal meadow

Mild cold-humid with summer rainfall.

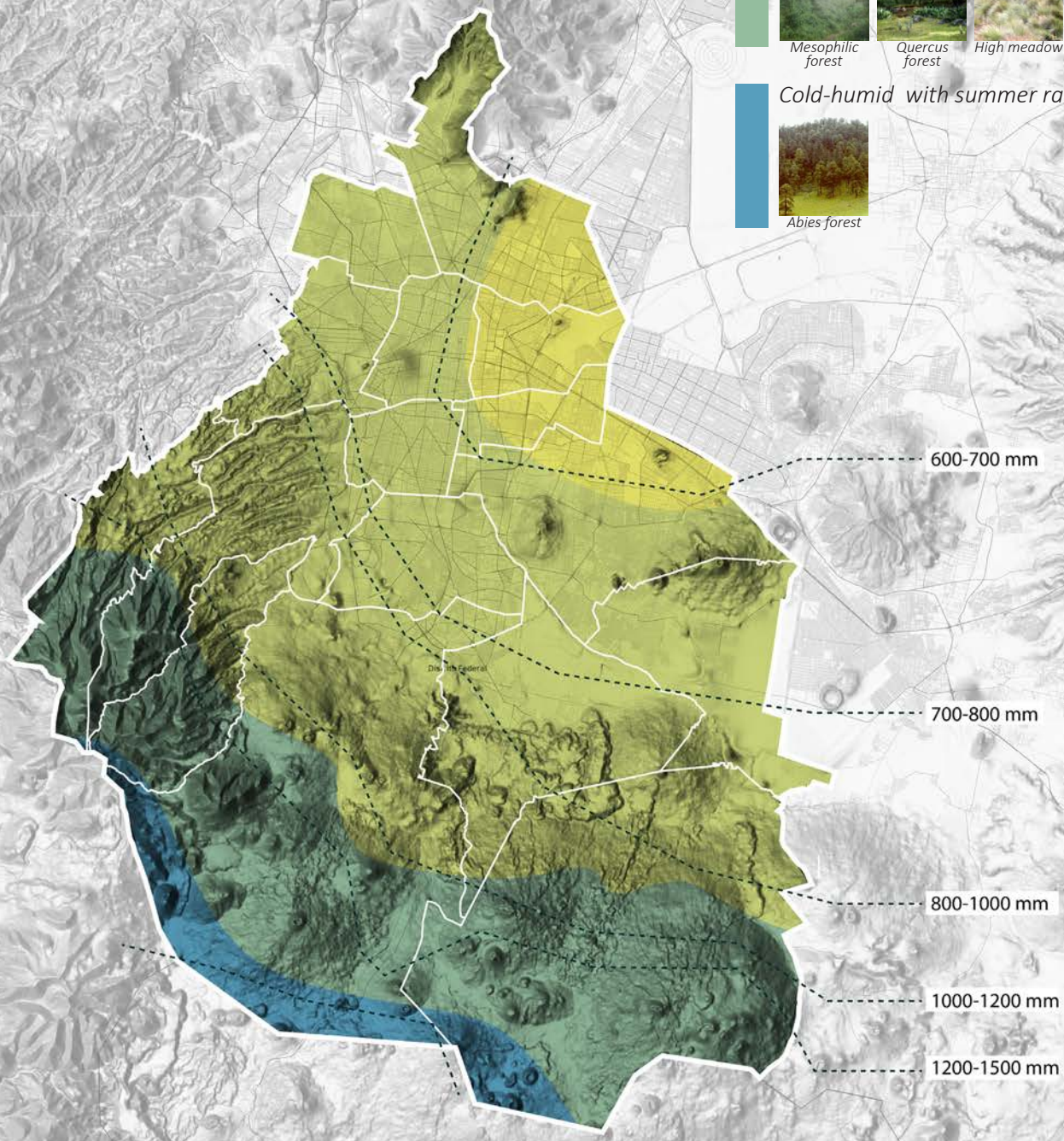
Mesophilic forest


Quercus forest

High meadow

Cold-humid with summer rainfall

Abies forest

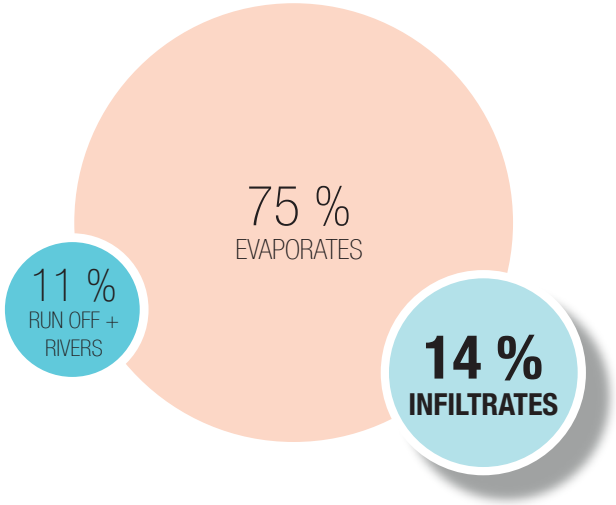


Espacio Escultórico at UNAM,
a space to contemplate inside the pristine volcanic rock landscape of the valley

HYDROLOGICAL MODEL OF MEXICO VALLEY
AQUIFER RECHARGE AREA

The best aquifer recharge area is along the Sierra Chichinautzin, the mountains of southern Mexico City, where the area of Ecological Conservation is located. The extension of undeveloped land, the low effect of the evapotranspiration, and the nature of its geologic composition of volcanic rocks, makes this area a suitable and potentially very interesting area to recharge water into the aquifer of Mexico City. These rocks in themselves are not permeable, but they have a large number of apertures and holes which create channels in which the water runs through. On the other hand, the urbanized area of the valley have a very limited level of infiltration due to expansive paved surfaces and the impermeability of the old sedimented clayish layers of the lake bed.

PERCENTAGE OF RAINFALL THAT INFILTRATES INTO THE AQUIFER, ANNUALLY



source : ATLAS GEOGRÁFICO DEL SUELO DE CONSERVACIÓN DEL DISTRITO FEDERAL
% *REPENSAR LA CUENCA: LA GESTIÓN DE CICLOS DEL AGUA EN EL VALLE DE MÉXICO*

PERCENTAGE OF POTENTIAL RECHARGE EFFECTIVENESS

INFILTRATION RATES IN THE CONSERVATION AREA

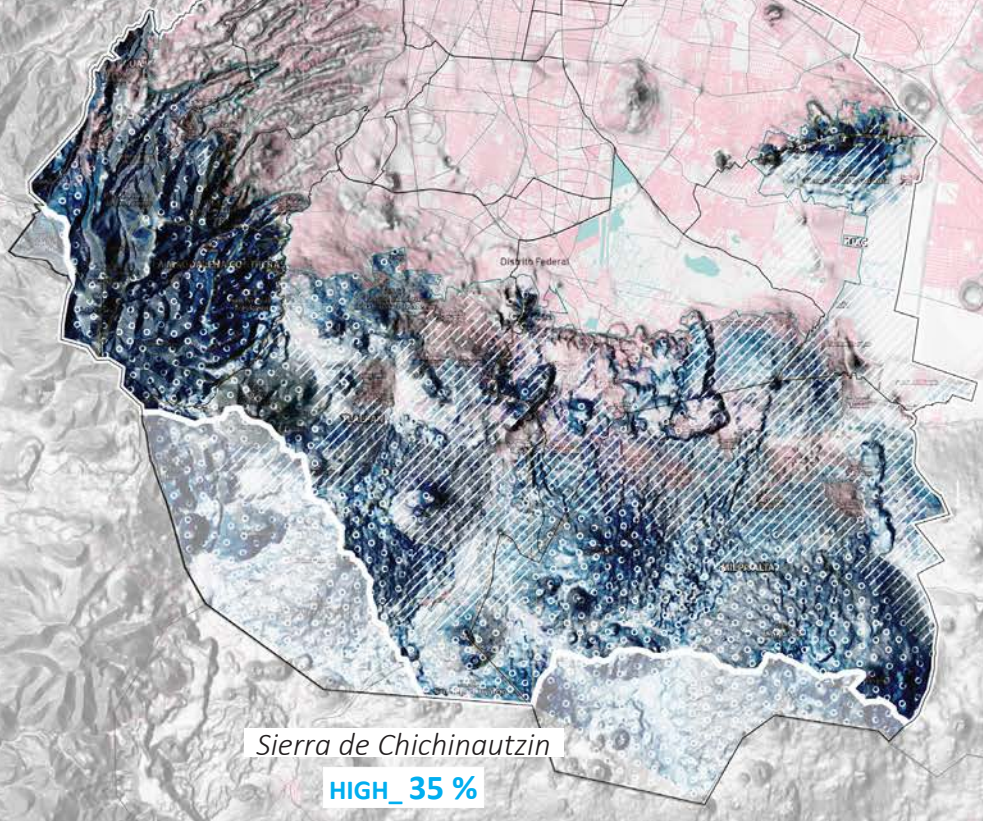
Sierra de Guadalupe
HIGH_ 30 %

Sierra de las Cruces
HIGH_ 18 %

Ancient lake bed
LOW_ 3 %

Sierra Nevada
HIGH_ 35 %

Sierra de Chichinautzin
HIGH_ 35 %



% OF RAINFALL THAT CAN POTENTIALLY INFILTRATE

% *high*

% *low*

Conservation area

Actual infiltration rates

HIGH: 35 mm/day

LOW: 0.08 mm/day

Rural-Urban land

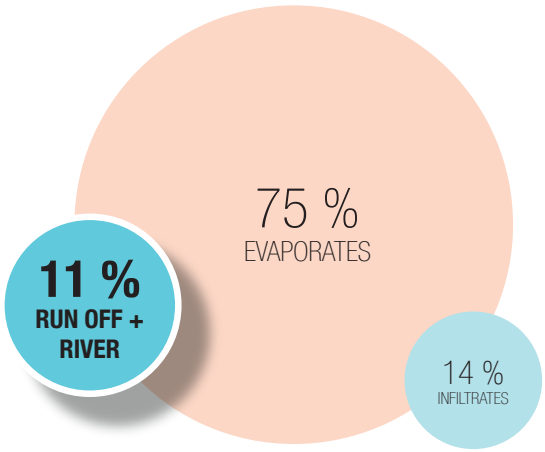
Forest land

Agricultural land

HYDROLOGICAL MODEL OF MEXICO VALLEY
NATURAL RUN OFF

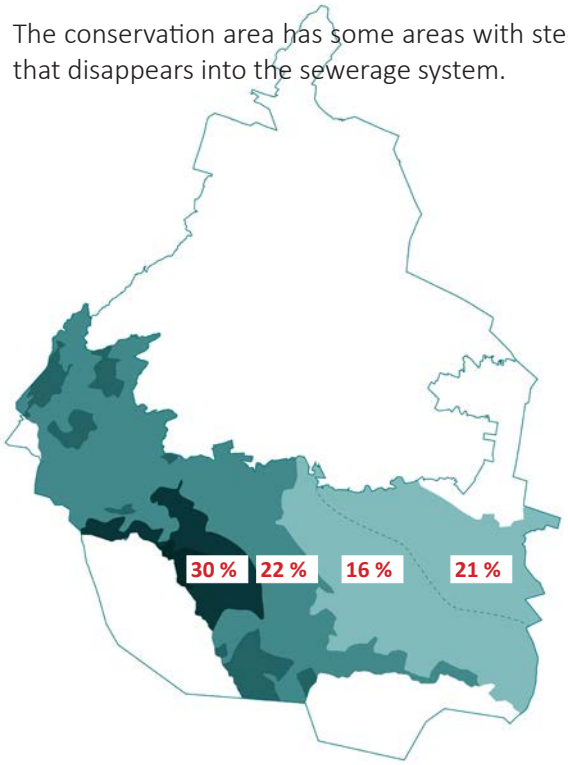
The loss of rainwater by natural run off happens in the conservation area. A portion of the rain that falls on this area of Ecological Conservation, drains into rivers and streams flowing through the Sierra Chichinautzin. At the same time a large part of the rain generates surface runoff which drains out into the sewerage system of the urbanized area situated on the lower boundary between the valley and the conservation area. This volume of water poses a risk due to the high speed that it reaches running down the slopes. At the same time, this volume of rain water is potentially clean water that is 'wasted', being passed into the sewerage system. This substantial total volume of runoff from the highest area amounts to almost the total volume of annual rain that falls in some boroughs of the urbanized valley like Venustiano Carranza and Iztacalco.

PERCENTAGE OF RAINFALL THAT RUNS OFF TO RIVERS, CANALS AND CREEKS ANNUALLY



PERCENTAGE OF RAIN LOST BY RUN OFF IN THE CONSERVATION AREA ANNUALLY

The conservation area has some areas with steep slopes, which generate fast surface runoff that disappears into the sewerage system.



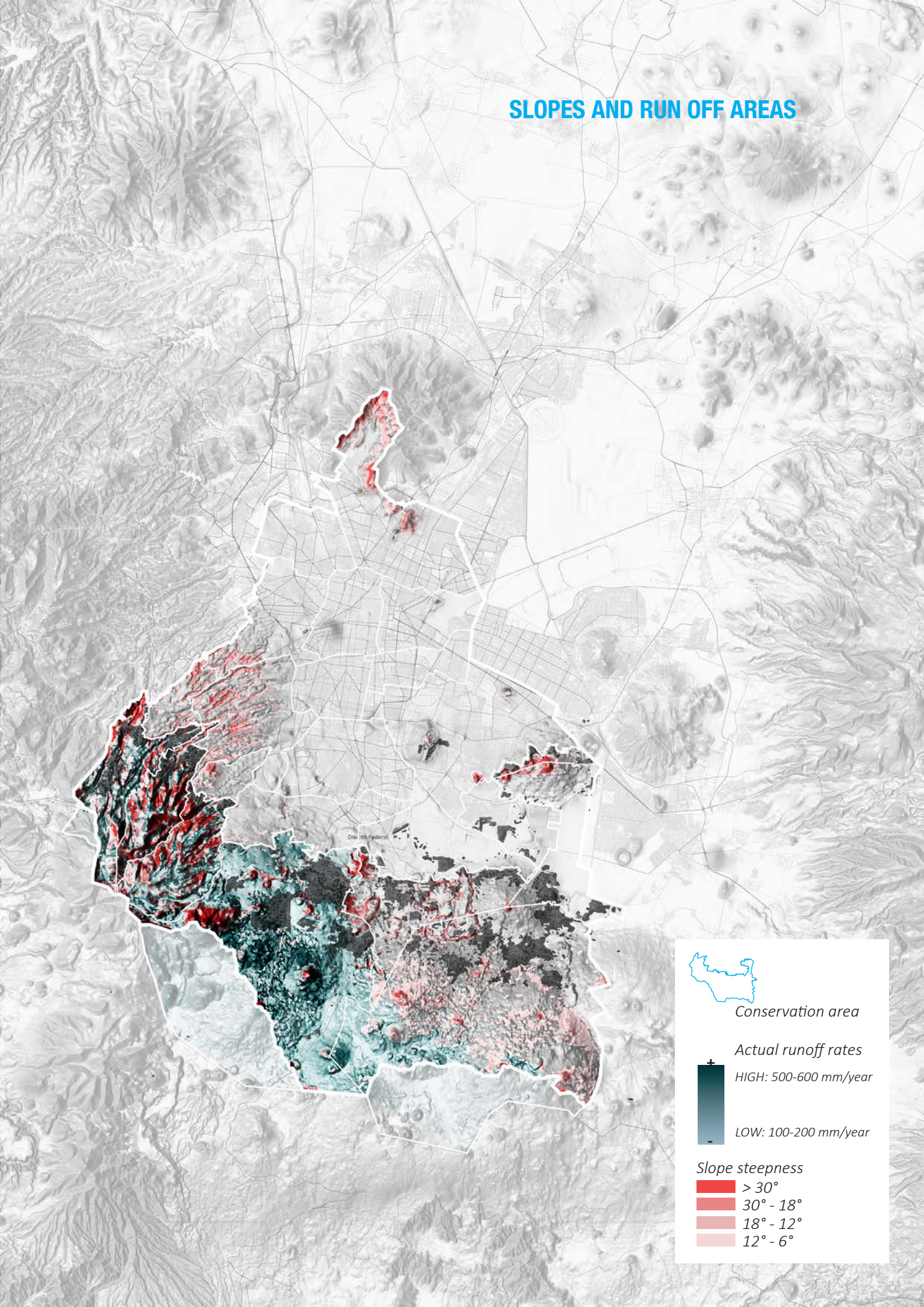
THIS MAP SHOWS THE ABSOLUTE AMOUNT OF ' LOST' RAINFALL BY RUNOFF ANNUALLY

- *501-600 mm / year*
- *401-500 mm / year*
- *301-400 mm / year*
- *201-300 mm / year*

% *Percentage of 'lost' rainfall compared to the total precipitation in the different climate areas of the conservation area.*

source : ATLAS GEOGRÁFICO DEL SUELO DE CONSERVACIÓN DEL DISTRITO FEDERAL
DIRECCIÓN GENERAL DE PROTECCIÓN CIVIL DEL DISTRITO FEDERAL

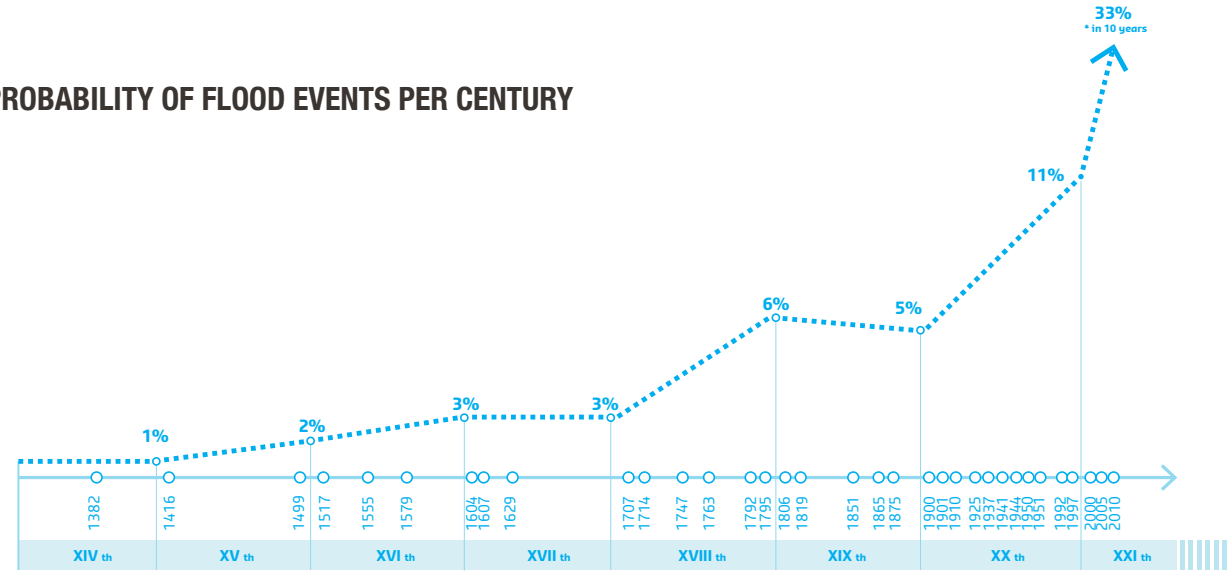
SLOPES AND RUN OFF AREAS



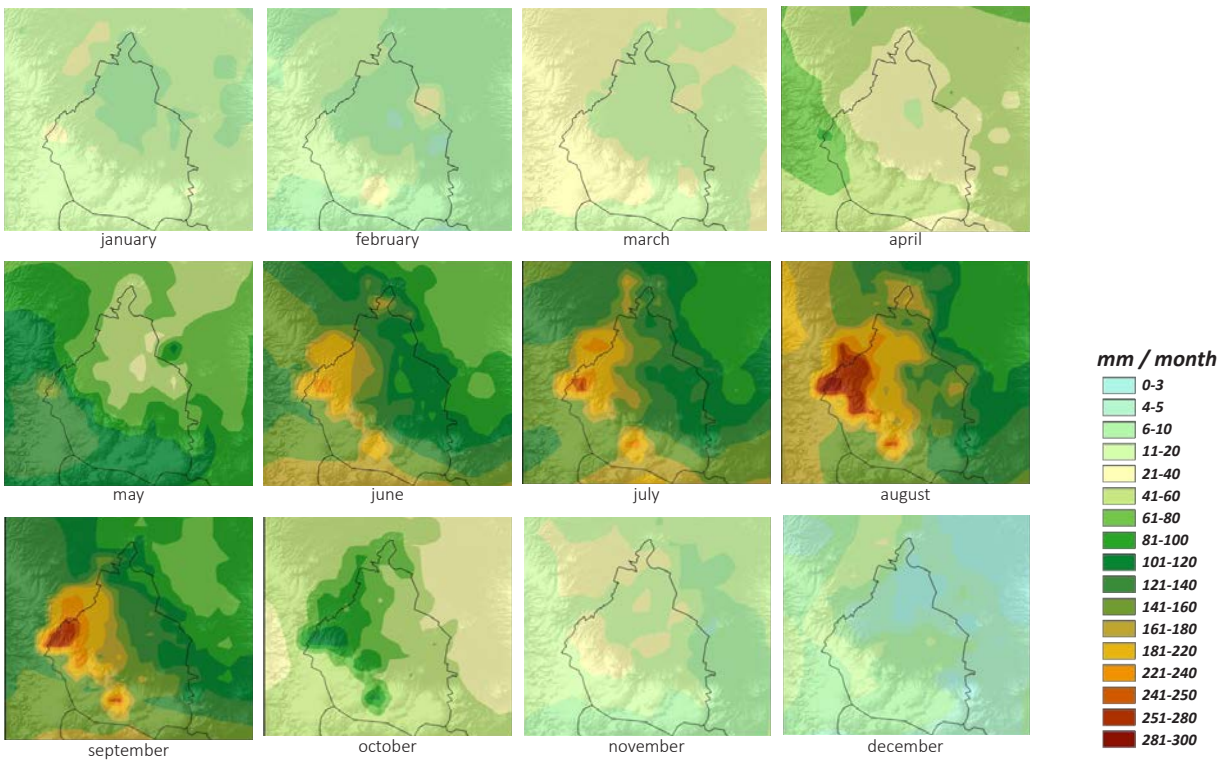
HYDROLOGICAL MODEL OF MEXICO VALLEY
FLASH FLOODS

The topographic condition of the valley determines the distribution of precipitation in Mexico City. The west and southwest areas at the foot of the sierra de Las Cruces, receive a higher amount of rain and a greater number of extreme rainfall events because of the natural run off illustrated on previous pages. In addition, the risk posed by the high probability of rain, is reinforced by the specific conditions of the terrain because along this area are located the most unstable volcanic sediments 'Lahar' and the most rugged and urbanized slopes in the city. It produces a fast runoff that cannot be digested by the underground sewerage system and it creates great damage, disruption and economic losses.

PROBABILITY OF FLOOD EVENTS PER CENTURY

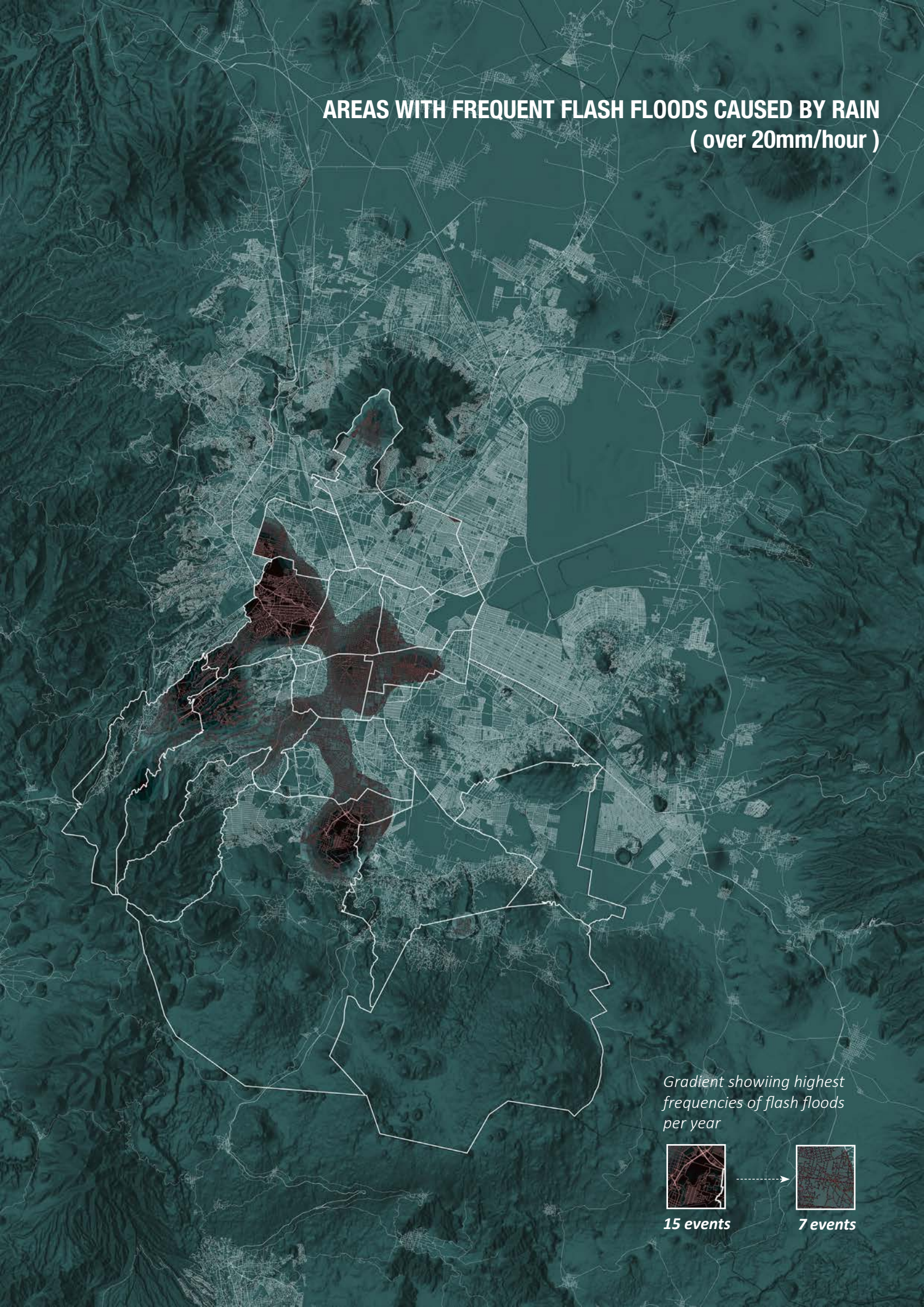


ACUMMULATIVE PRECIPITACION (MM / MONTH)



source : STUDY ON CLIMATE CHANGE, DISASTER RISK MANAGEMENT AND THE URBAN POOR MEXICO CITY CASE STUDY.

AREAS WITH FREQUENT FLASH FLOODS CAUSED BY RAIN
(over 20mm/hour)



Gradient showiing highest frequencies of flash floods per year

15 events ***7 events***

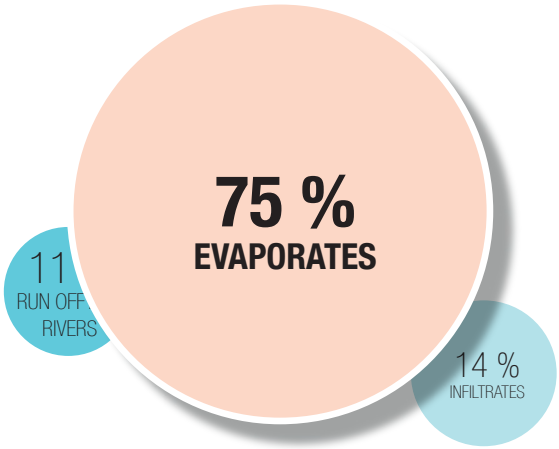
CIUDAD DE MÉXICO
Decidiendo Juntos
113
CDMX

Flash floods are an increasing risk in Mexico City

HYDROLOGICAL MODEL OF MEXICO VALLEY
EVAPORATION AREAS AND HEAT WAVES

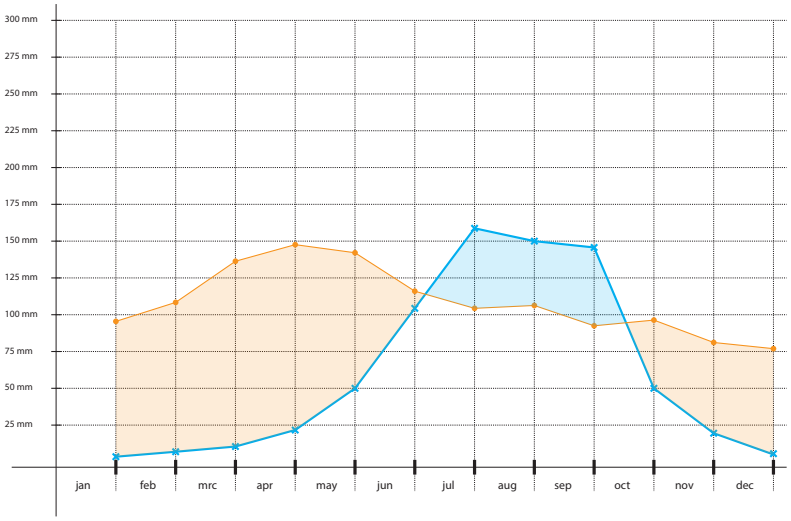
Evapotranspiration is the loss of moisture of a surface where the water is returned to the atmosphere. It consists of the amount of evaporation caused by the local climate conditions, the type of soil and subsoil, and if the water can be captured by vegetation, depending on their specific metabolisms. In Mexico city this atmospheric phenomenon represents the main destination of rain water that enters the basin. The eastern zone of Mexico city in particular, boroughs like Iztapalapa and Tláhuac, are the most affected by this process. The evapotranspiration here is linked to heat waves and their frequency, to the impermeable soil and to a shortage of green infrastructure. One of the negative consequences of the evapotranspiration is the effect that it has on the soil, making it slightly more saline. This condition limits the implementation possibilities of vegetation and consequently increases the heat island effect in this part of the city.

PERCENTAGE OF RAINFALL THAT IS ' LOST' BY EVAPORATION ANNUALLY



PRECIPITACION VERSUS EVAPORATION

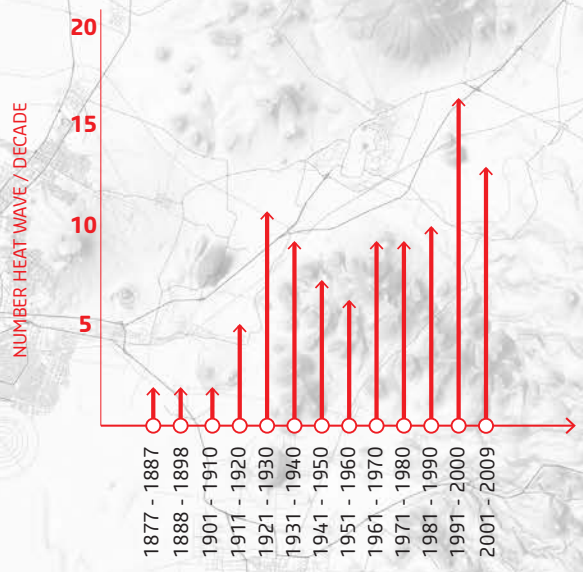
During the dry season, evaporation is the most influential variable in the Valley of Mexico City, causing great losses of surface water. The wet season only lasts for three months approximately.

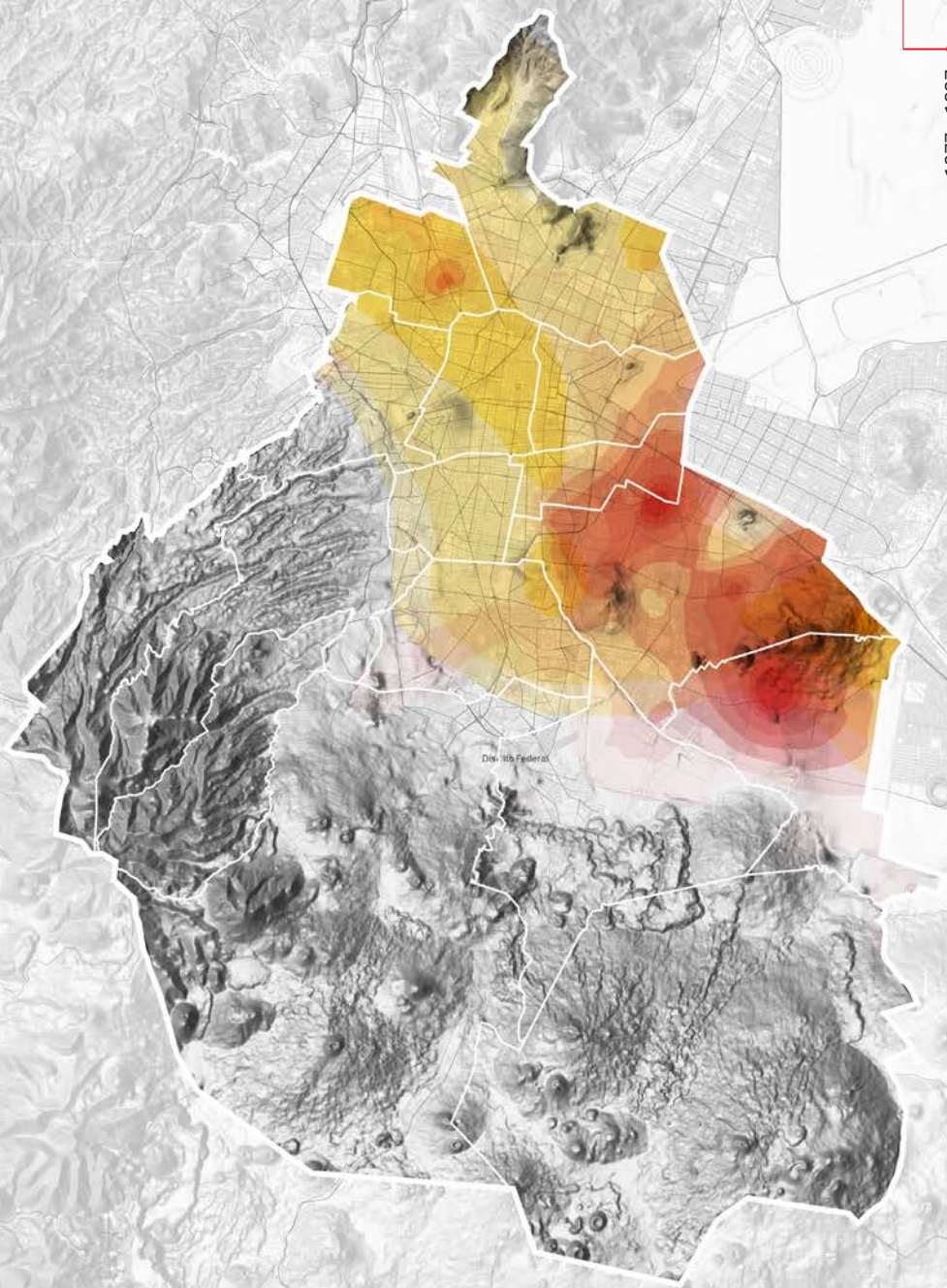


source : STUDY ON CLIMATE CHANGE, DISASTER RISK MANAGEMENT AND THE URBAN POOR MEXICO CITY CASE STUDY.

GRAPH SHOWING FREQUENCY OF HEAT WAVES

* Defining Heat wave as 2 or more days over 30° (including nights!)





NUMBER OF HEAT WAVES

- *31-40 events / year*
- *21-30 events / year*
- *16-20 events / year*

EVPORATION RATES

[XX] *Chloride concentration as evaporation marker.*

High evap.

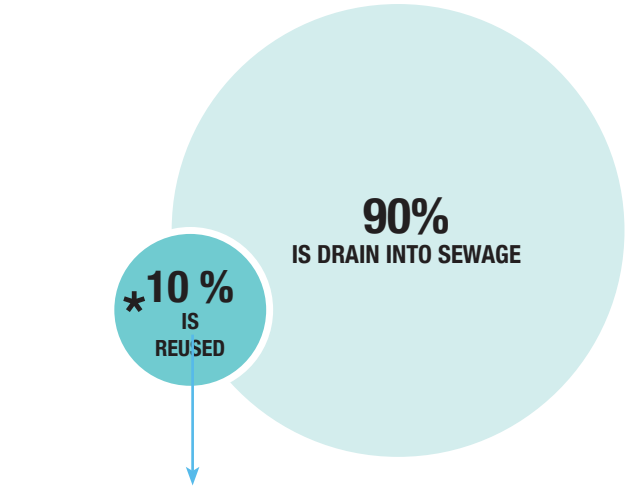
Med evap.

Iztapalapa is one of the most affected boroughs by heat waves and evapotranspiration

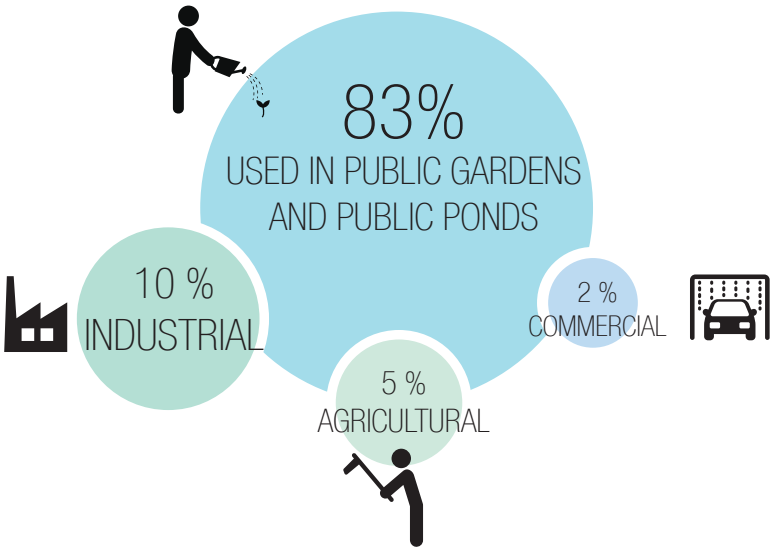
HYDROLOGICAL MODEL OF MEXICO VALLEY
DRAINAGE SYSTEM

The drainage system of Mexico City is a large scale complex system of mixed sewerage infrastructure that collects rain water, grey water (household) and black water (sewage). Through a series of collectors the water is discharged into a main underground system that transports all mixed waste water outside of the urbanized valley basin. Originally, the 'Grand Canal de Drenaje', drained away the water on the surface. But due to the gradual collapse of subsoil, the capacity of the canal has dramatically reduced because its natural slope disappeared, until it even at some point in time was reversed by subsidence and totally lost its effect. For this reason, the city is currently expanding deep underground drainage infrastructure like, El Túnel Emisor Oriente, to restore the capacity. A lot of rainwater losses in the urbanized valley bed are caused by its total dependence on this drainage system. Here all pavement and pipes lead the rain water as soon as possible to the deeper drainage. The water cannot evaporate, it has no time to infiltrate and especially in the eastern parts of the city, the moisture cannot be held by covering trees, because there hardly are any that can survive in the given circumstances.

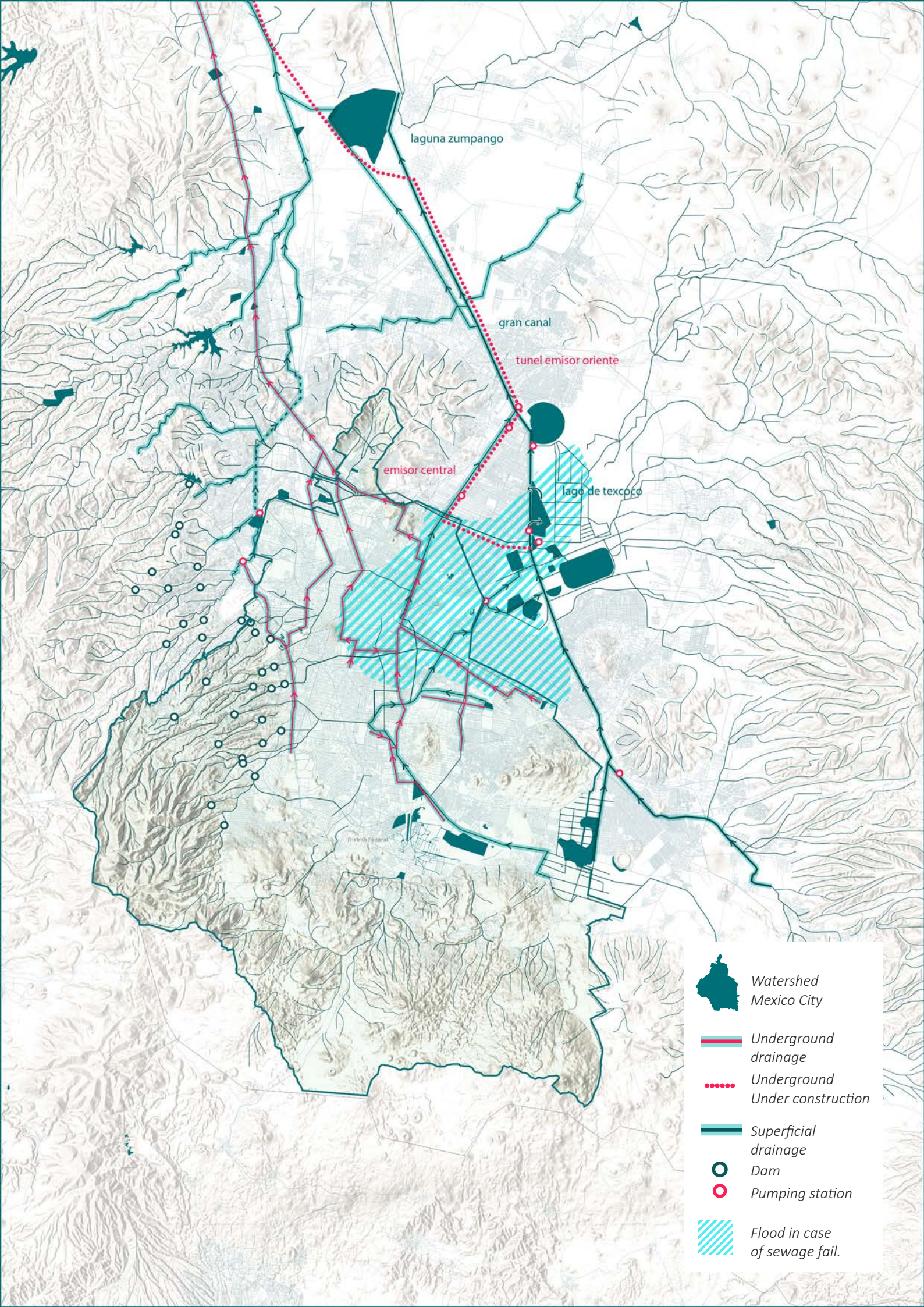
PERCENTAGE OF 'LOST' WATER BY DRAINING IT VIA THE SEWERAGE INTO THE NEXT WATERSHED



DESTINATION OF REUSED WATER



source : Acciones de infraestructura de drenaje y abastecimiento de agua en el Valle de México 2007-2012_CONAGUA.
: Mapa interactivo drenaje ciudad de Mexico CONAGUA
** Data from 2008 Celorio, Gonzalo, et.Al.Mexico, Ciudad Futura, Blok Design, Barcelona: RM. c2010*


laguna zumpango
gran canal
tunel emisor oriente
emisor central
lago de texcoco
Watershed
Mexico City
Underground
drainage
Underground
Under construction
Superficial
drainage
Dam
Pumping station
Flood in case
of sewage fail.

A new subterranean drainage infrastructure for the city

En cinco etapas se rehabilitaron 48.5 kilómetros de túneles del drenaje profundo, con una inversión de 1,643 millones de pesos en el periodo 2007–2012.

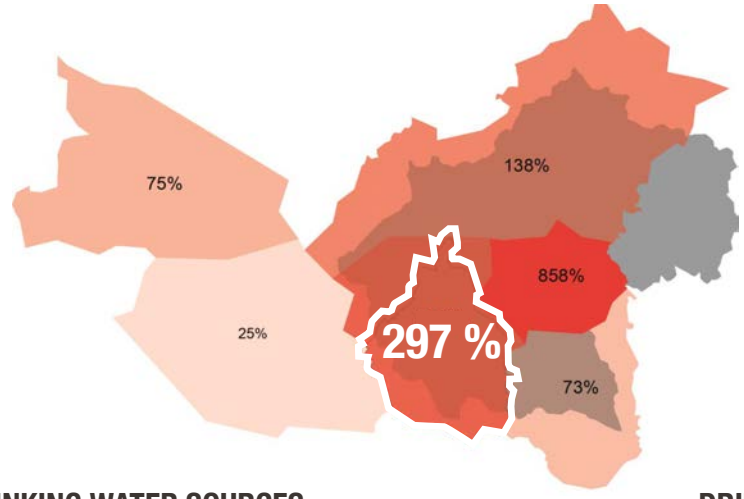
HYDROLOGICAL MODEL OF MEXICO VALLEY
AQUIFER EXPLOITATION AND DRINKING WATER PROVISION

The supply of drinking water to Mexico City is another issue to be addressed. It will require a combined strategy to ensure the basic supply of potable water to the entire population of the city. On one hand Mexico City, being one of the largest metropolises of the world, needs a lot of water to equitably provide every citizen with water in the first place. This now has led to a combination of importing water from basins some hundreds of kilometres away, into the city and in addition to the drilling of many wells- also illegally- to obtain water from the deeper aquifers. Mexico City is currently beyond pushing the limits of its own resources offered by the aquifers. This is partly caused by an uneven distribution and consumption in the city. The delegations in the Eastern parts of the city receive volumes of drinking water far below the city average, even to the point that potable water occasionally has to be distributed by delivery trucks in barrels among its population.

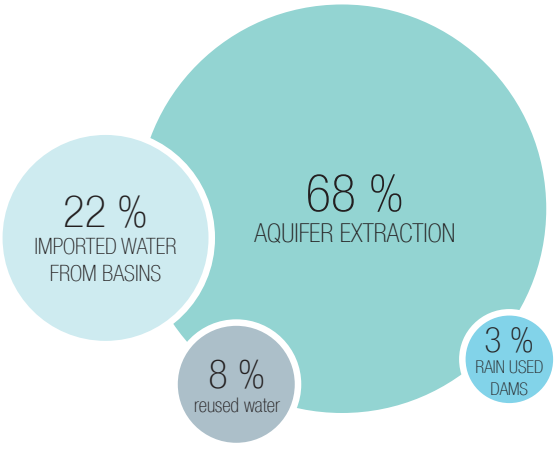
On the other hand, if one looks at global statistics of water consumption, this problem also requires a new mentality for better use of drinking water. The average consumption of the Mexico City population exceeds the double (!) of the average consumption advised by the World Health Organization in large cities. While at the same time the costs of this scarce primary need is far below the average world standard. Another problem is that a staggering 40% of the potable water is currently lost in infrastructure leaks.The combination of excessive use and seasonal shortages will need a more circular approach to the water cycle. As a start, the maintenance of public spaces and vegetation could be connected to the reuse of rain water instead of using precious potable water, which could already relieve the system substantially.

AQUIFER OVER EXPLOITATION

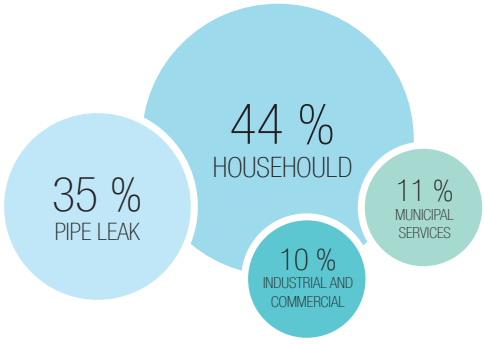
* The basin of Mexico City and adjacents aquifers.



DRINKING WATER SOURCES



DRINKING WATER USAGE



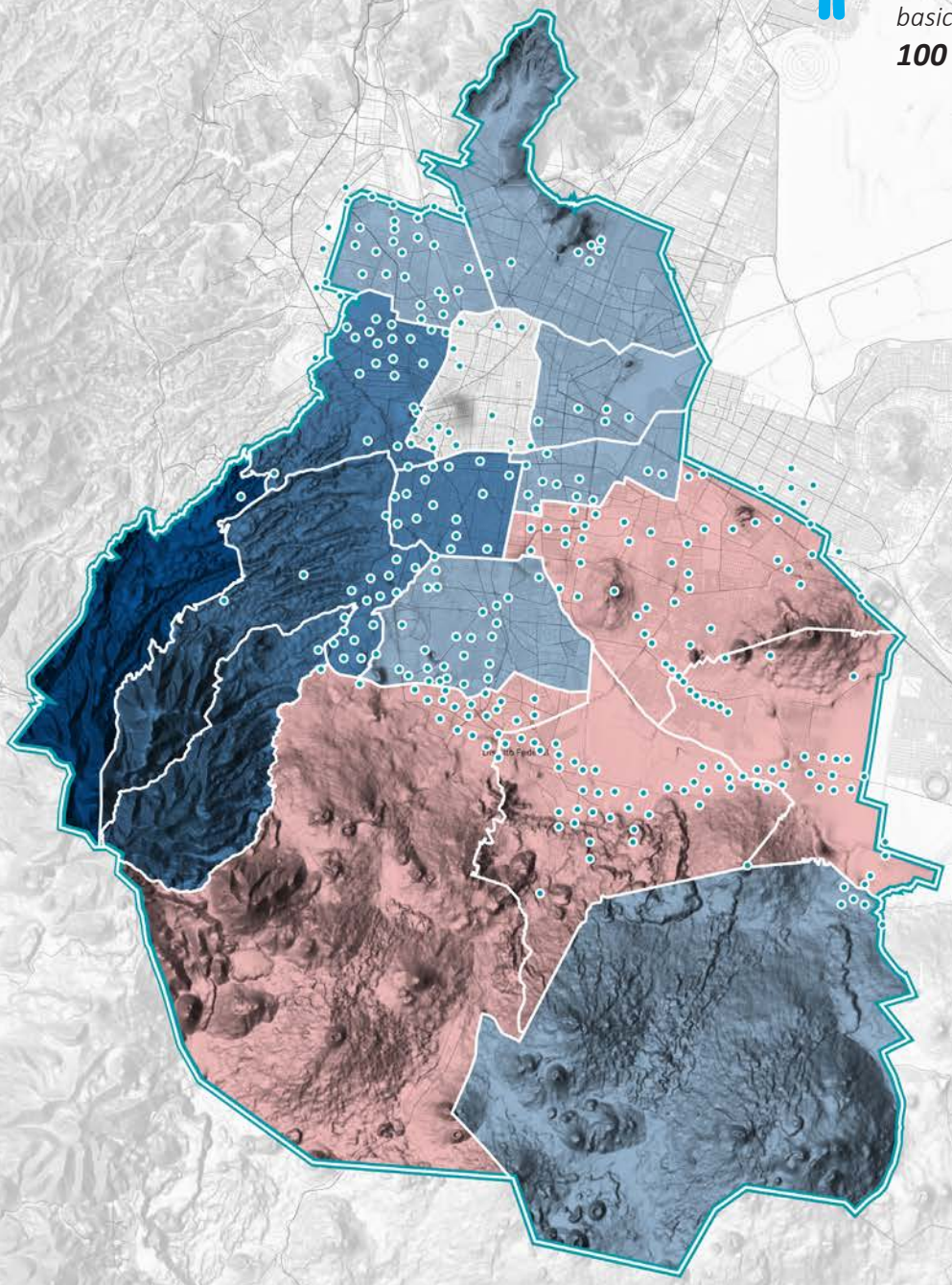
*source : * Evaluación energética de los actuales sistemas de aguas urbanas y propuestas de manejo de los recursos hídricos en la Ciudad de México, CENTRO MARIO MOLINA.*

: REPENSAR LA CUENCA: LA GESTIÓN DE CICLOS DEL AGUA EN EL VALLE DE MÉXICO

DRINKING WATER PROVISION PER MUNICIPALITY

Average daily consumption of water per capita in Mexico City: ***327 liters*** *

World Health Organization (WHO) and the SMA-DF estimate that domestic consumption needed to meet basic needs for large cities is ***100 to 150 liters*** *per day per person.*



AVERAGE OF DRINKING WATER PROVISION PER MUNICIPALITY

Above average

- *+ 600 L*
- *400 - 500 L*
- *300 - 400 L*

Below average

- *200 - 300 L*

- *Well distribution*

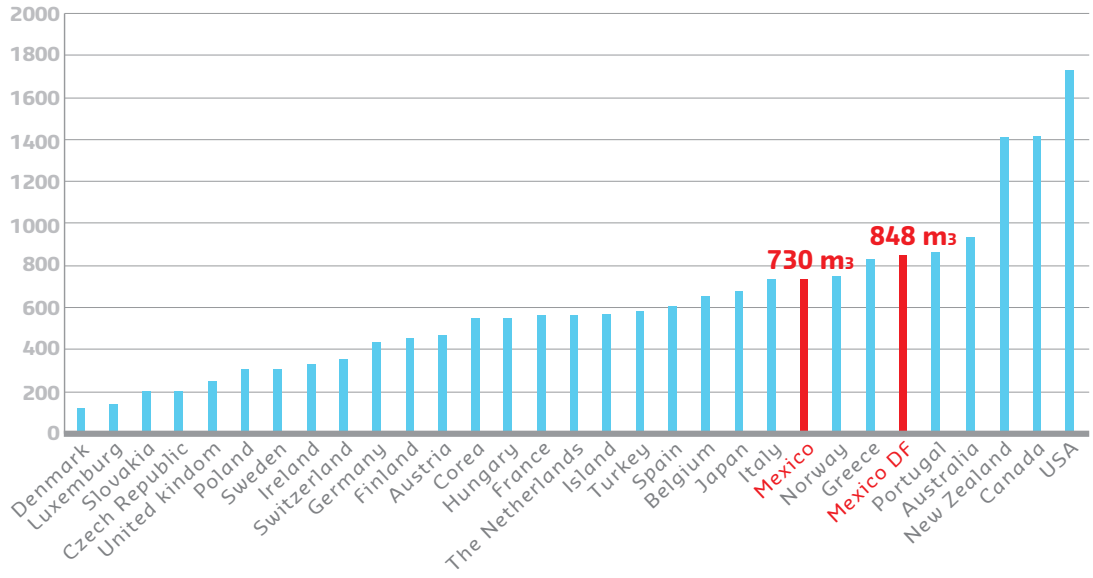
*(*Consejo de Evaluación del Desarrollo Social del DF & UNAM, 2010)*

AGUA POTABLE

Water delivery truck repleting a drinking water shortage

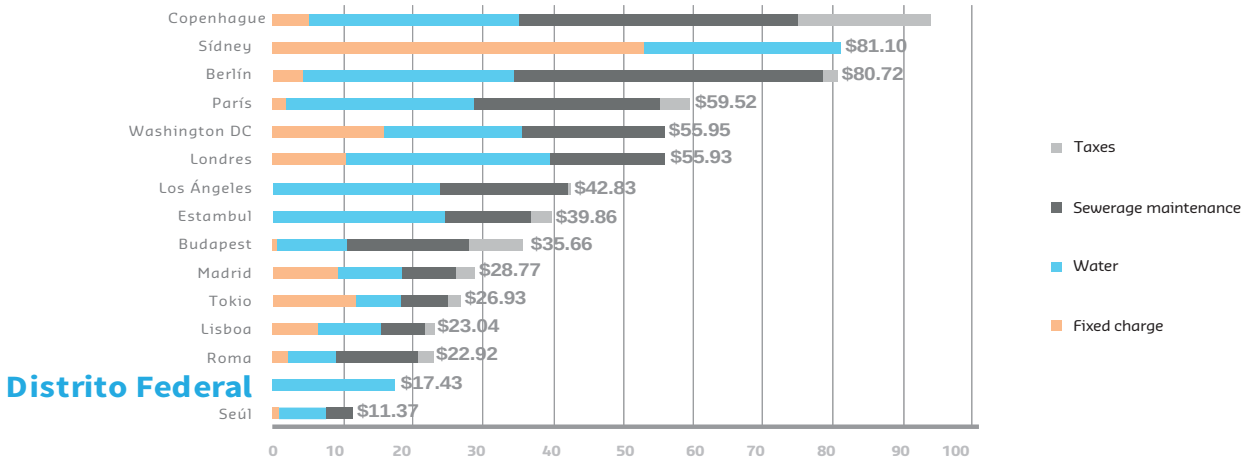
HYDROLOGICAL MODEL OF MEXICO VALLEY
DRINKING WATER CONSUMPTION

ANNUAL DRINKING WATER EXTRACTION PER INHABITANT

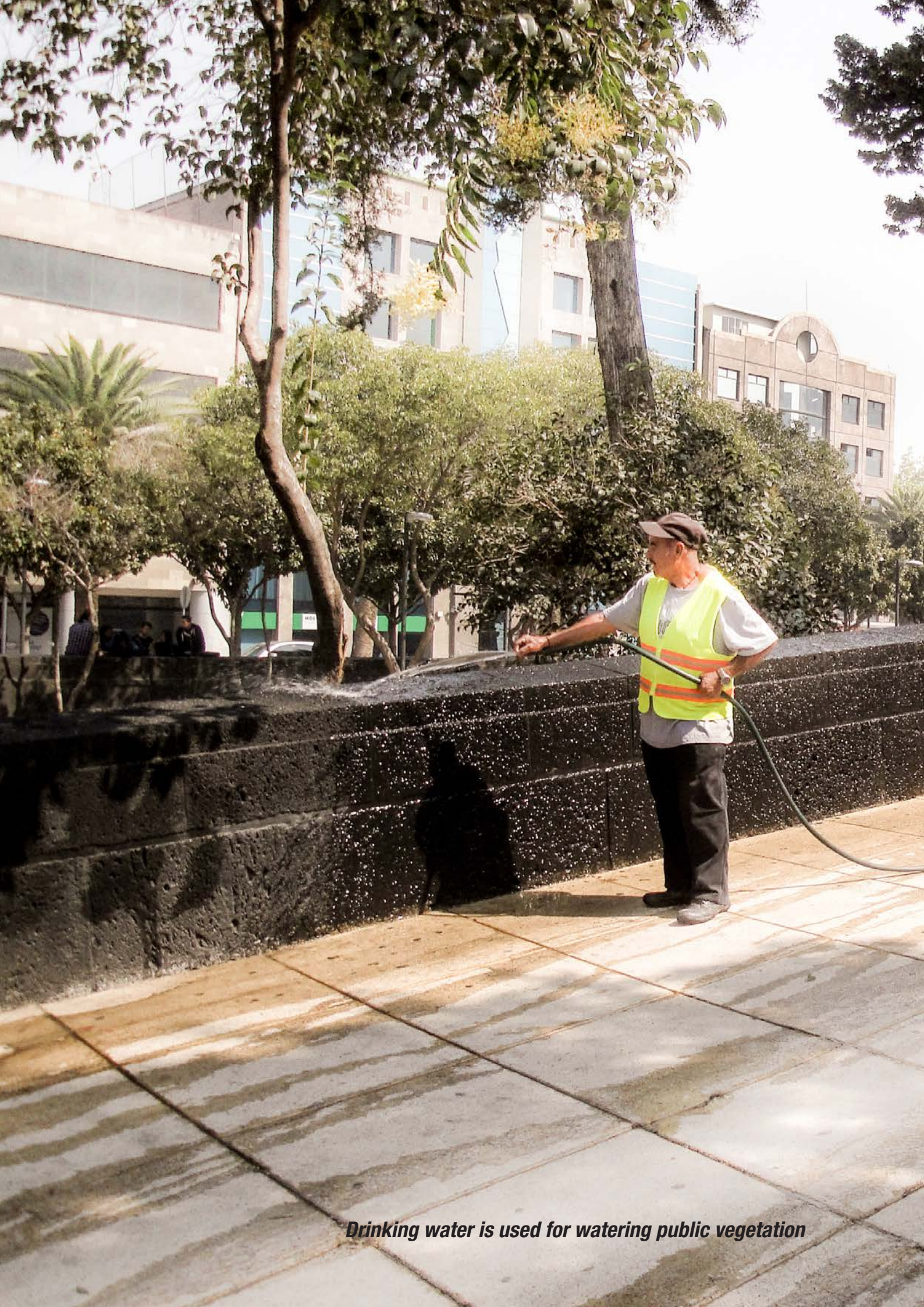


FEES FOR DRINKING WATER, SANITATION AND TAXES ASSOCIATED WITH THESE SERVICES IN CITIES AROUND THE WORLD, 2008

* Domestic rates (pesos / m3 for a consumption of 15m3 / month)



source : DATOS PARA EL DISTRITO FEDERAL OBTENIDOS DE ESTADÍSTICAS DE AGUA EN MÉXICO 2008, SEMARNAT
: ESTADISTICAS DEL AGUA EN LA CIUDAD DE MEXICO_2015_ COMISION NACIONAL DEL AGUA
: Evaluación energética de los actuales sistemas de aguas urbanas y propuestas de manejo de los recursos hídricos en la Ciudad de México, CENTRO MARIO MOLINA.

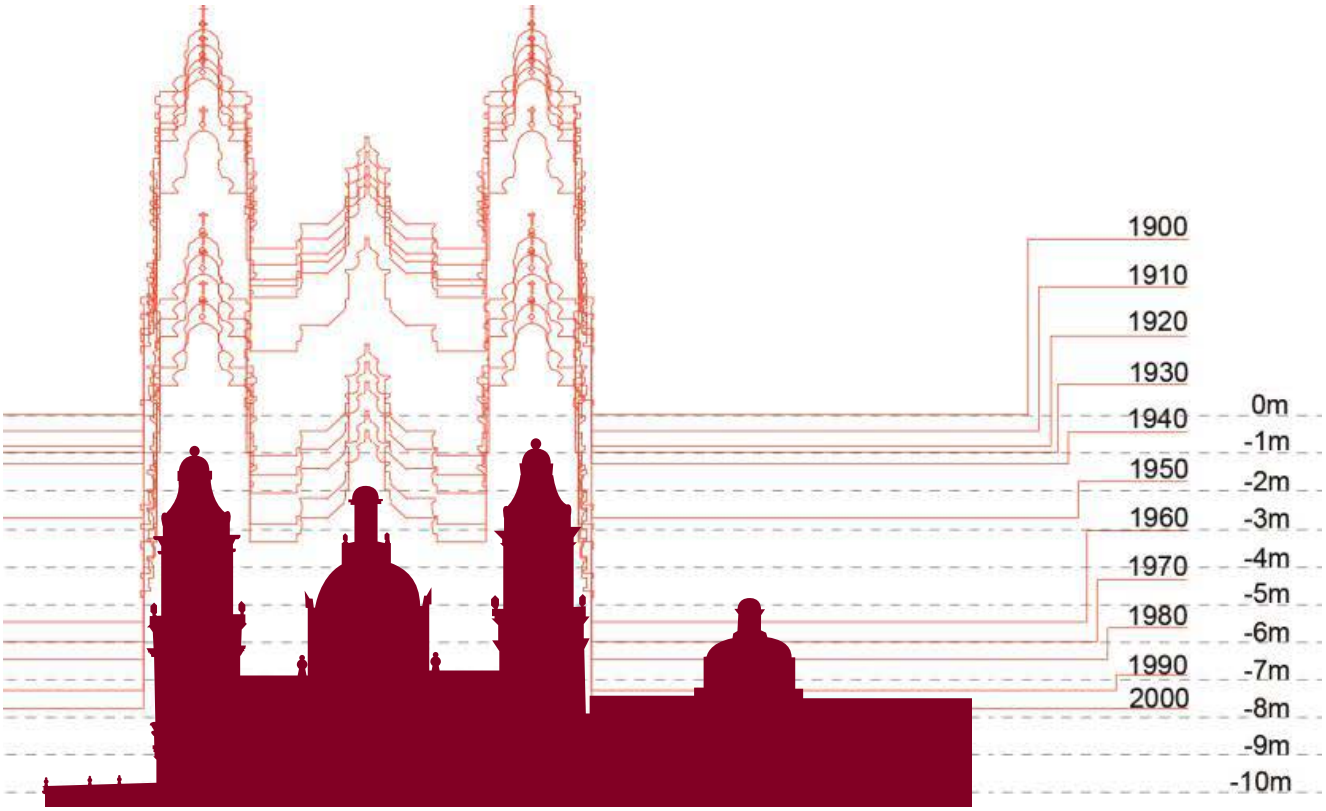


Drinking water is used for watering public vegetation

HYDROLOGICAL MODEL OF MEXICO VALLEY
SUBSIDENCE

Mexico City suffers from substantial and progressive subsidence. It is one of the main problems that the city has to face and it is immediately related to the disturbed water cycle of the city. The soil under Mexico City consists of a semipermeable layer with a high content of clay- the so called aquitard- which has its origin in the ancient lake bed. This layer originally caused a relatively constant level of water in the lake and at the same time recharged the aquifer under the lake by very slow infiltration via the wet clay, maintaining the balance between surface water and groundwater.

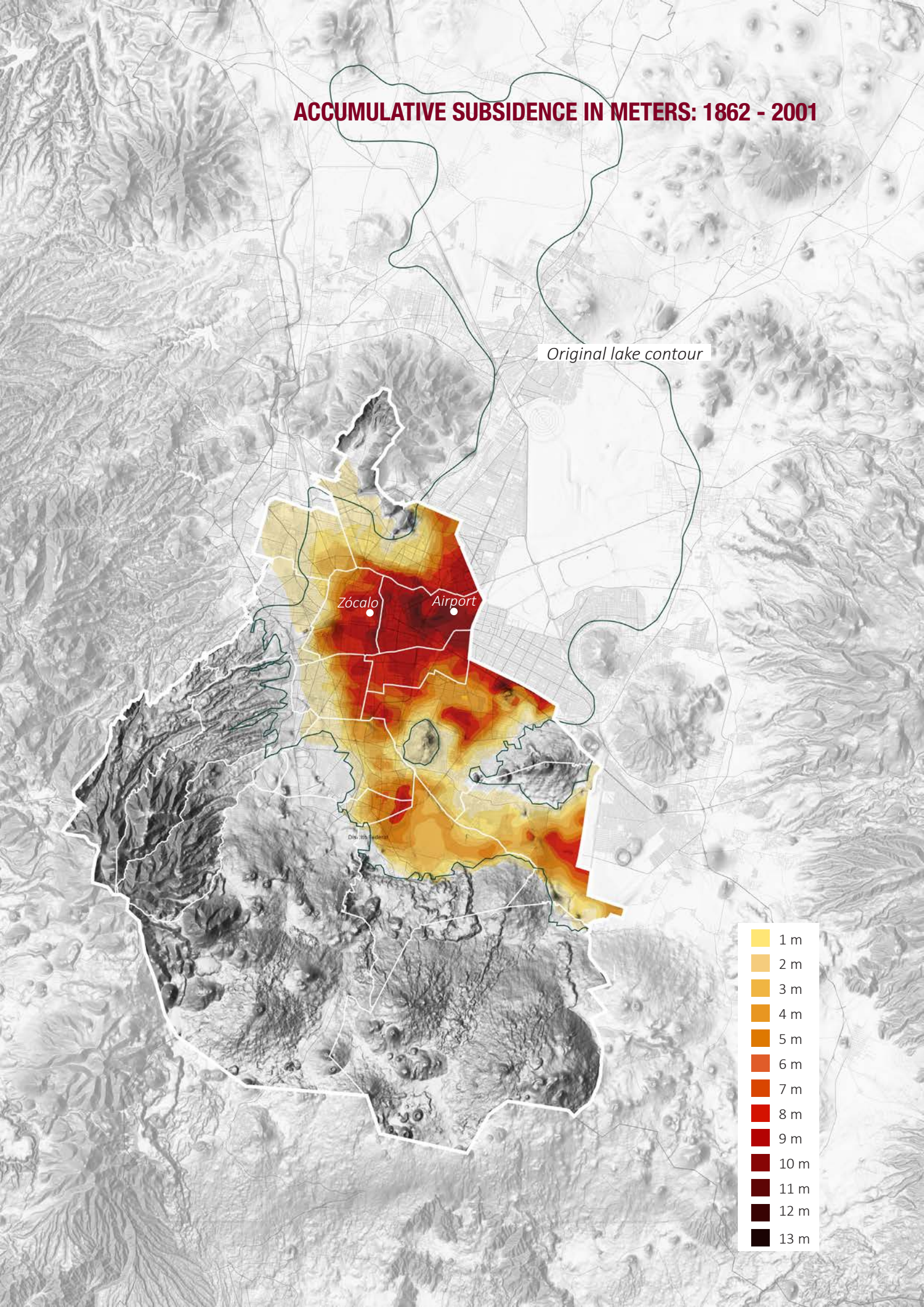
Currently all the rain water that falls on the valley is drained out of the urbanized area, ruling out the possibility to recharge the aquifer under the city. At the same time more and more water is extracted from the aquifer, causing the underground water to sink. This water extraction without refilling causes the soil to sink with subsidence as result. Another effect of draining is the dehydration of the top layer of the soil. A process of water extraction and oxidation causes the clay layers to collapse and to compact under the load of the cities urbanization. Some parts of the city like the airport and Zócalo, sink at a staggering rate of more than 80 millimetres annually.



THE SINKING OF THE CATHEDRAL ON ZÓCALO HAS BEEN MEASURED FOR THE PAST 100 YEARS

source : SACMEX ,el gran reto del agua en la ciudad de mexico.
Evaluación energética de los actuales sistemas de aguas urbanas y propuestas de manejo de los recursos hídricos en la Ciudad de México, CENTRO MARIO MOLINA.

ACCUMULATIVE SUBSIDENCE IN METERS: 1862 - 2001



Axtel
HSBC

The stairs of El Angel de la Independencia need to be prolongued on a regular basis, to make sure that the monument is still connected to its sinking surrounding

BUILDING UP A WATER SENSITIVE CDMX

PUBLIC SPACE ZONING AS AN OVERALL WATER MANAGEMENT STRATEGY

CHAPTER 4

In order to understand the hydrological cycle of the Mexico City, it is important to realize that all the aforementioned variables are interconnected in one way or another. The analysis of all layers should be understood as parts of a whole cycle. What happens in the hills has its consequences in the valley. The loss of the infiltration in the mountains, negatively affects the water volume of the aquifer and increases the pressure on the availability of drinking water. Draining all water out of the city as soon as possible, in addition to the reduction of the aquifer volume, accelerate the subsidence of the city.

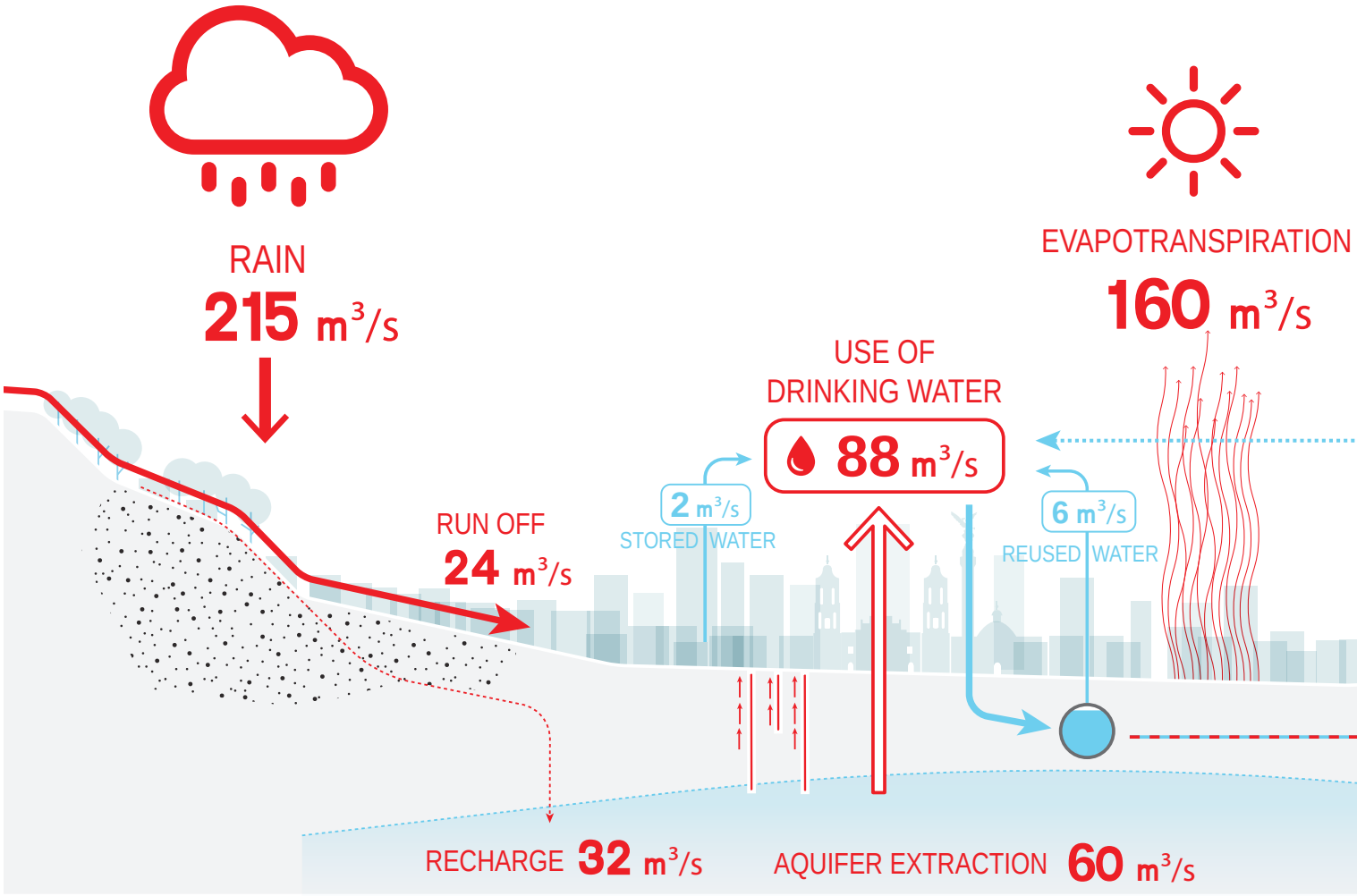
The solutions we offer can be understood as contributions to healing the disturbed water cycle of Mexico City. A water sensitive public space strategy includes offering measures that solve local problems and at the same time make an effective contribution to restoring the water balance for the entire city. To do so, we have to distinguish different zones in the city and connect the most urgent problems to the appropriate types of water sensitive measures.

Therefor in this chapter, zoning the public domain of Mexico City is deployed as an overall water management strategy by the motto: 'Delay, retain, store and reuse, drain only when necessary'. The disturbed water cycle is restored, by subsequently applying the most appropriate component of this motto. How this can affect the water cycle in a positive manner and how it can be connected to different specific geographical zones in the city will be described. This results in a 'Water sensitive strategy map' for Mexico City containing main goals per geographical zone. In chapter six these zones will each be connected to a catalogue of water sensitive possibilities. But first we focus on the revision of the current hydrological cycle of the entire basin of Mexico City by understanding its specific risks in specific geographical zones and by intervening accordingly, based on their urban, geographical and hydrological conditions.

WATER SENSITIVE APPROACH

DELAY **RETAIN** **STORE** **REUSE**

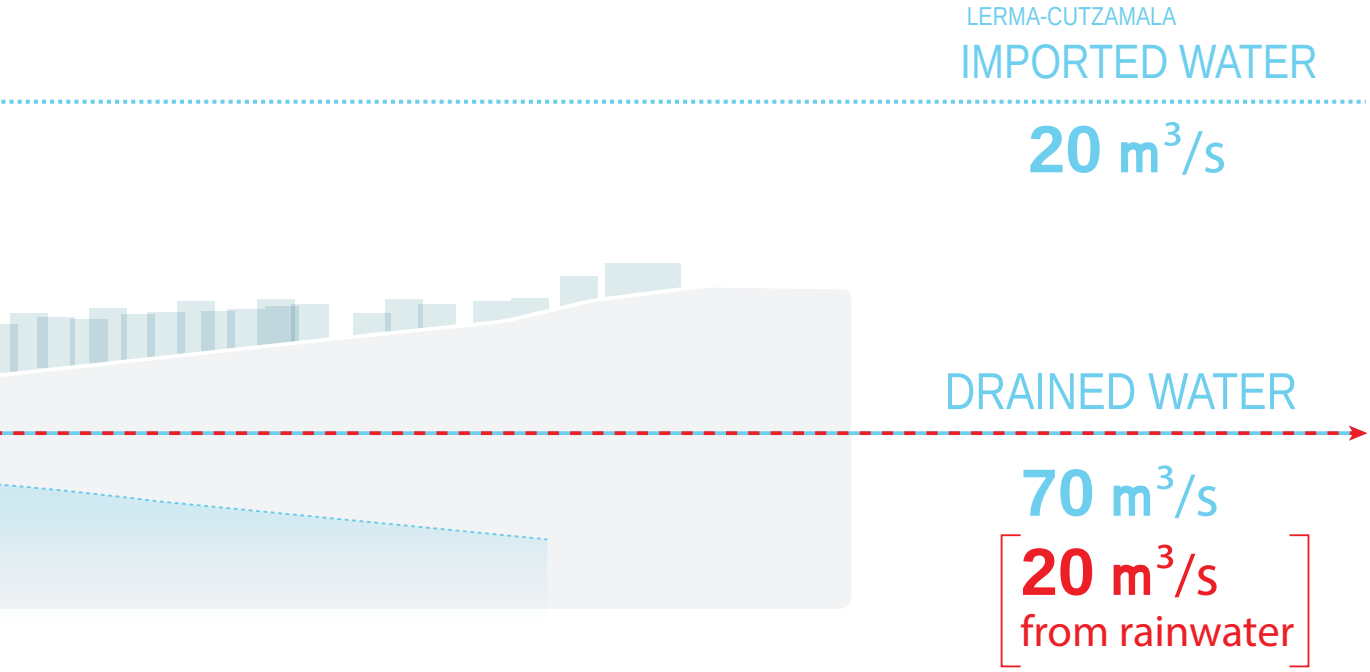
CURRENT BALANCE DISTURBANCES



The amount of rain that enters the basin (215 m³/s) and the amount of water that evaporates (160 m³/s) has been virtually the same since the time of the city of Tenochtitlan. These numbers have remained unchanged, unlike all the other volumes that are shown. The volumes of water that recharge the aquifer have decreased due to the cutting down mountain forests. This vegetation performs an important role in delaying and retaining rain water by decreasing the volume of runoff and distributing it more evenly on the slopes of the hills, allowing the rain to infiltrate. The decreased amount of forest allows the rain to speed up down the hills where the majority of the runoff reaches the lower basin of the valley. This causes flooding on the foothills, decreases the volume of water that can recharge the aquifer by infiltration and increases the volume of runoff that needs to be digested by the subterranean drainage system.

source : AGUA URBANA EN EL VALLE DE MÉXICO:¿Un camino verde para mañana?_March 2013
: SACMEX ,el gran reto del agua en la ciudad de mexico.
: Evaluación energética de los actuales sistemas de aguas urbanas y propuestas de manejo de los recursos hídricos en la Ciudad de México, CENTRO MARIO MOLINA.

This abstract graphic section of the valley of Mexico City shows the present hydrological cycle as a freeze frame containing the volumes of water that enter and leave the valley on average per second. On the basis of this scheme we can make some observations.



Concerning the aquifer balance it is relevant to notice that the amount of extracted water (64 m³/s) as a source for drinking water, doubles the volume of rain water that currently can recharge it (32 m³/s). This depletes the aquifer and the soil becomes compacted causing subsidence. To meet the great demand for drinking water, it is necessary to import water from other basins outside of Mexico City, while at the same time large volumes of water are exported out of the city (70 m³/s), including relatively clean rain water (20 m³/s).This number is particularly interesting since it shows that the volume of drinking water to be imported equals the amount of rain water that is lost in the drainage system (20 m³/s). Since only a small portion of drinking water is actually used for drinking, this creates the opportunity to think about reusing rain water instead of draining it away, while at the same time reducing the demand for drinking water. Even without decreasing the absolute volumes of water usage, this scheme indicates that it is theoretically possible to create a more circular and self-sustaining system.

ACCUMULATION OF PROBLEMS CONNECTED TO GEOGRAPHICAL ZONES

The disturbed water balance has been translated into one map that overlaps the main problems associated with the hydrological cycle of the Mexico City. It sums up the analysis of the previous chapter into one image that allows us to have an overall idea of how different problematic areas are distributed in the geography of the valley of Mexico. It also shows how some areas are more affected than others according to the risks they face. Generally, the western part of the city has to deal with excess of water, while the eastern part of the city suffers from a lack of water. We propose to divide the city into the following six zones based on their different geographical, hydrological and urban characteristics:

1 *VOLCANIC MOUNTAINS_CONSERVATION AREA*

This unbuilt protected area has substantial infiltration potential. But through past deforestation of the slopes large volumes of water run off the mountain without being delayed, causing great risks downhill.

2 *SLOPES_SOUTH, EAST, NORTH*

The slopes form the transition area between the mountains and the low urbanized basin. Water that runs off the mountain slopes is hardly being slowed down here, since large parts of these slopes are becoming more and more (partly illegally) urbanized. The increased paving of surfaces only further accelerates the water downhill.

3 *LAHAR SLOPES_WEST*

The western slopes have the same type of risks as the previously described slopes, only more reinforced by their intense urban development combined with an instable geological base. The runoff is concentrated in a few lines of water that can reach extremely dangerous speeds, causing high risks for landsides.

4 *WEST BASIN_ORIGINAL FRESH LAKE*

The western part of the basin where the original freshwater lake was situated represents perfectly the current paradox of Mexico City's relationship with its water. Here flooding problems related to heavy rains and drought problems caused by a lack of water and strong heat waves, overlap. This is also the oldest urbanized area of the city with the highest population density.

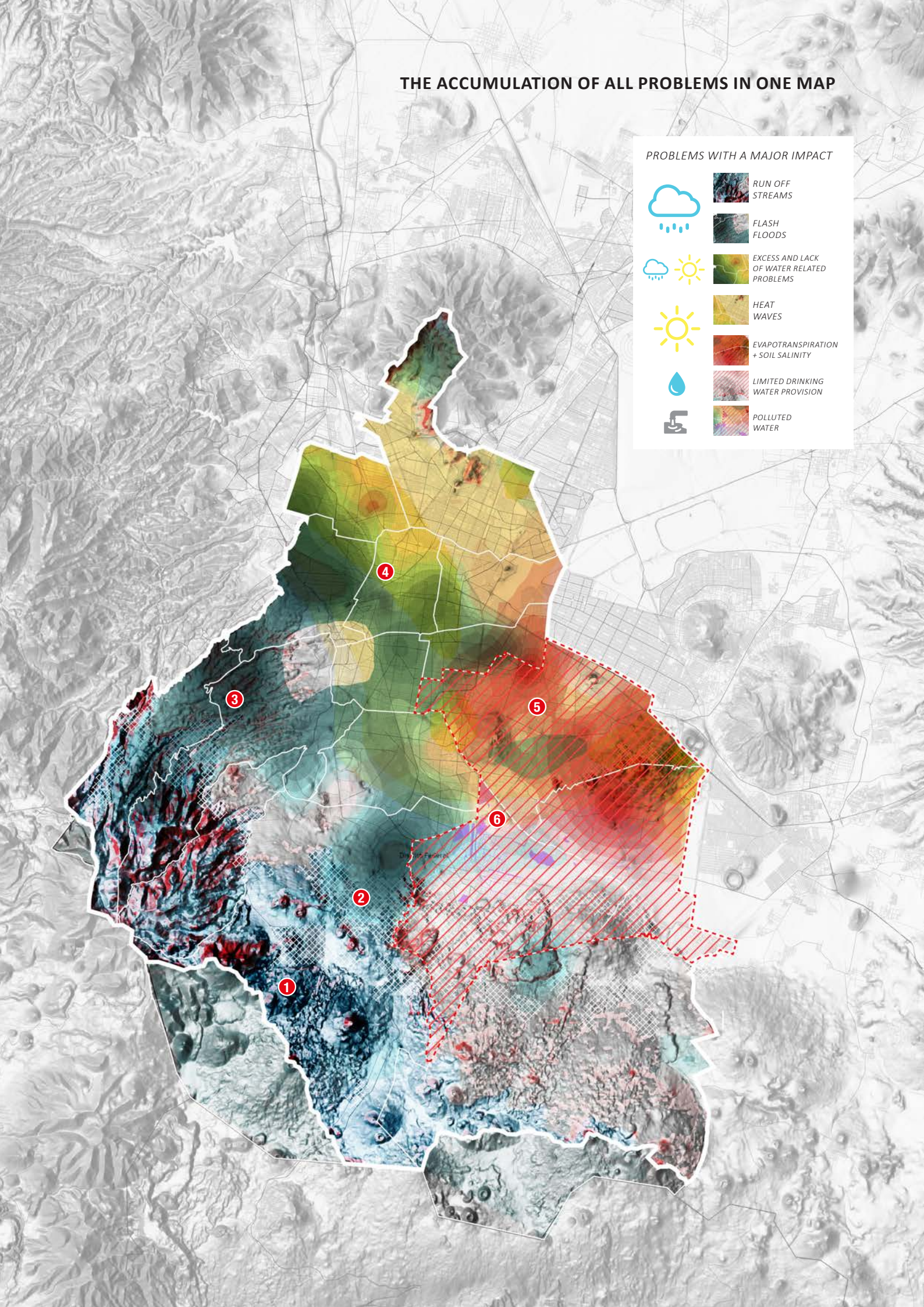
5 *EAST BASIN_ORIGINAL SALTY LAKE*

The eastern part of the basin where the original salt water lake was situated, has an accumulation of problems related to heat waves, including high evapotranspiration and a lack of drinking water. Here a lot of water extraction takes place which increases the effects of subsidence. Furthermore, this part of the city is home to a high concentration of socially vulnerable individuals.

6 *XOCHIMILCO*

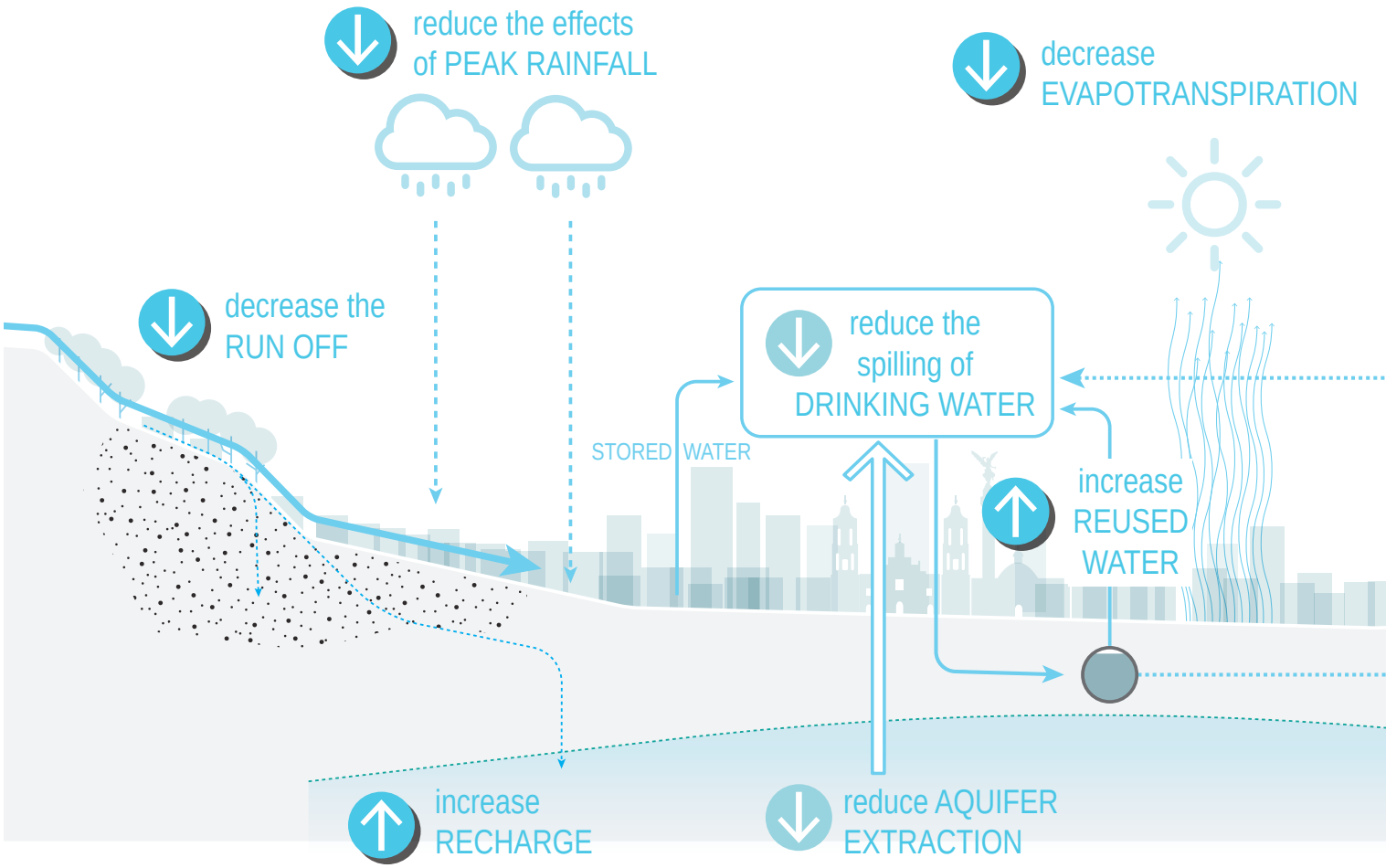
The area of Xochimilco is the last ancient (agri)cultural landscape within Mexico City that shows its original harmony between the water and the city. Currently this ecological zone is pressured by illegal urban settlements dumping their sewage waste water into the vulnerable system of lakes and channels. Subsequently the availability of clean water is serious problem.

THE ACCUMULATION OF ALL PROBLEMS IN ONE MAP

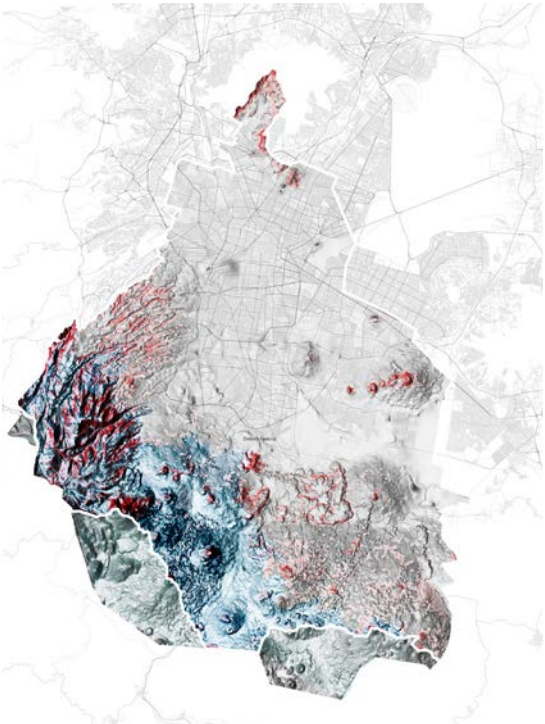


HOW TO RESTORE THE HYDROLOGICAL BALANCE VIA PUBLIC SPACE INTERVENTION

DIRECT EFFECT
INDIRECT EFFECT



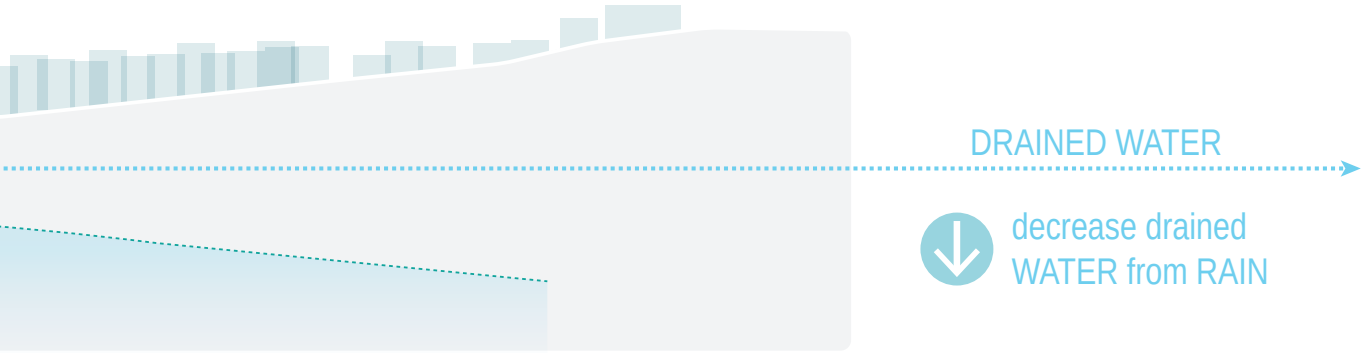
Decrease runoff and increase infiltration



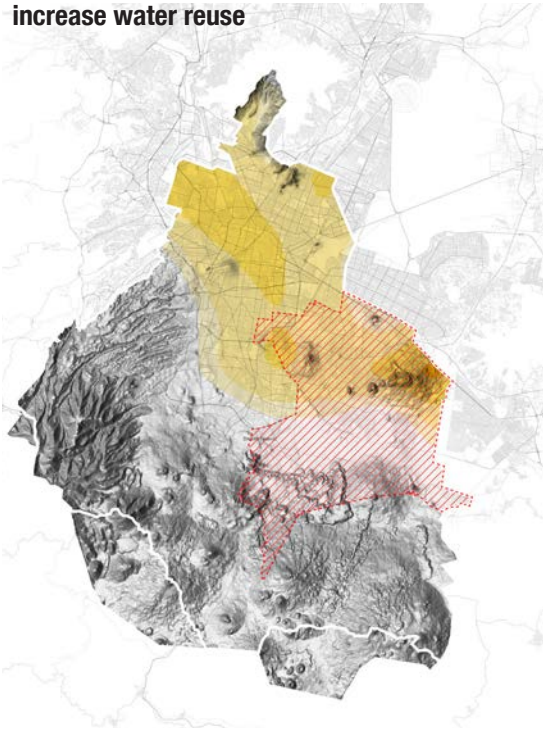
Decrease the impact of flash floods

In the graphic section the points within the hydrological balance are shown where the implementation of physical measures via public space have a positive effect on risks reduction. These effects are mostly direct effects, like decreasing the volume of runoff and increasing the recharge of the aquifer. Sometimes they are indirect effects like decreasing the need for imported drinking water. In all cases the interventions into the hydrological balance are done to solve specific problems related to specific areas where they are most effective.

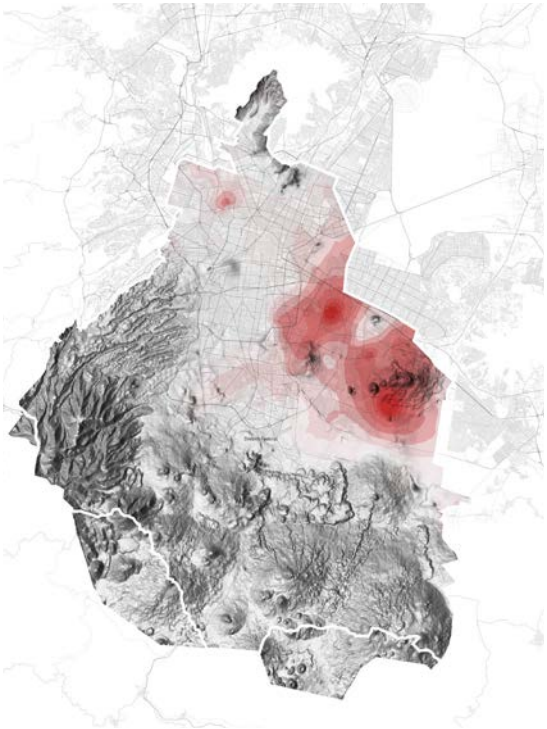
Therefore the sequence of maps show where specific interventions have an immediate positive effect. Here reducing runoff, increasing aquifer recharge, increasing rain water reuse and decreasing the effects of evapotranspiration, are points in the water balance of Mexico City where interventions in public space as smart water management strategies will prove beneficial. Indirect effects like the reduction of aquifer extraction, require a raise in public awareness regarding the daily consumption of drinking water. Since this is not primarily a physical measure in public space, we only mention it briefly in the context of this study. Nevertheless it is of major importance to reduce the overall pressure on water demand in Mexico City.



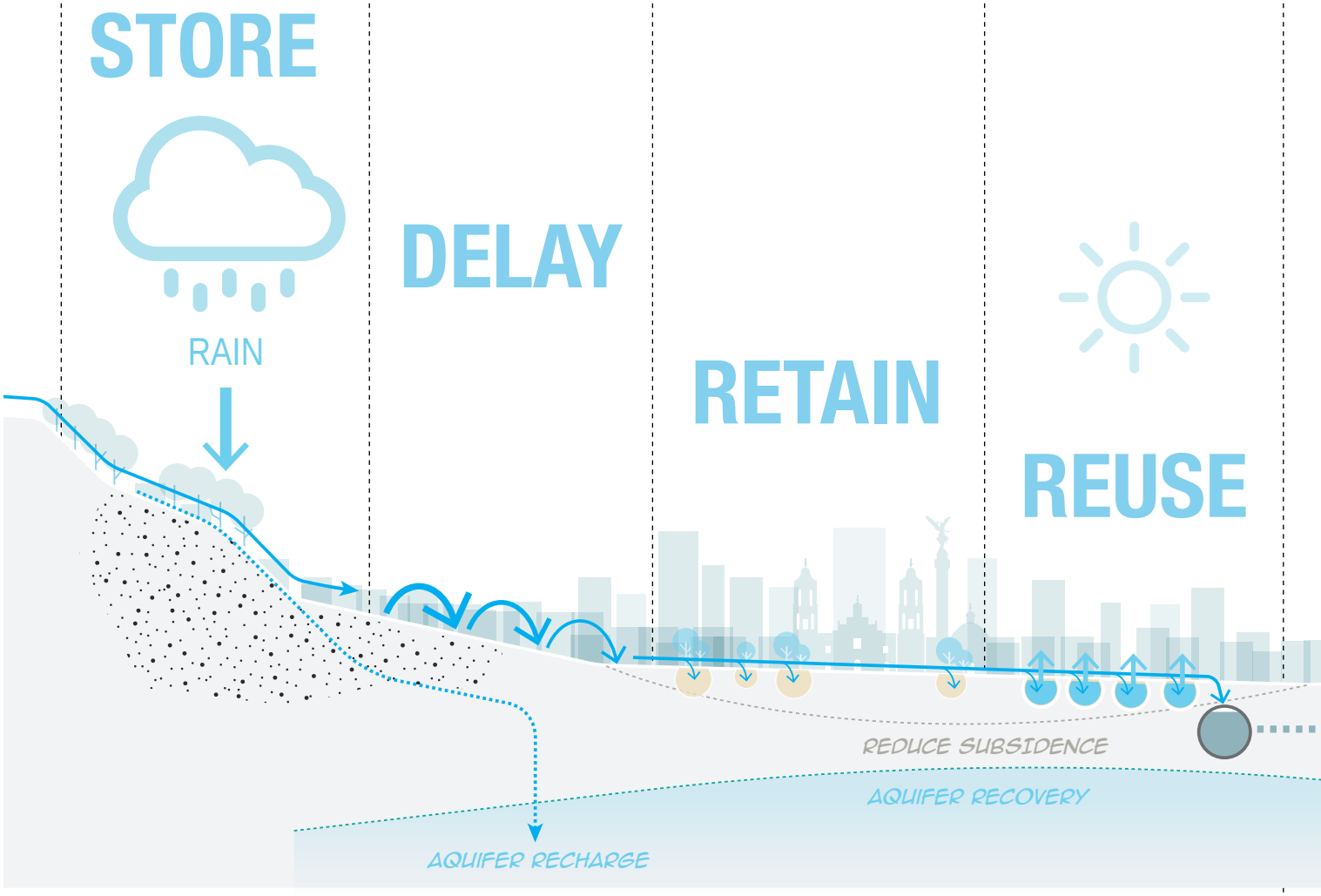
Decrease impact of heat waves and increase water reuse



Decrease evapotranspiration levels

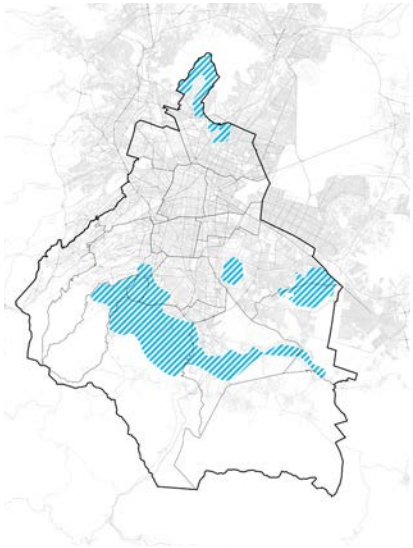


PROPOSED STRATEGY TO RESTORE THE HYDROLOGICAL BALANCE RELATED TO SIX DIFFERENT ZONES IN THE CITY



❶ **DELAY + STORE**
VOLCANIC MOUNTAINS

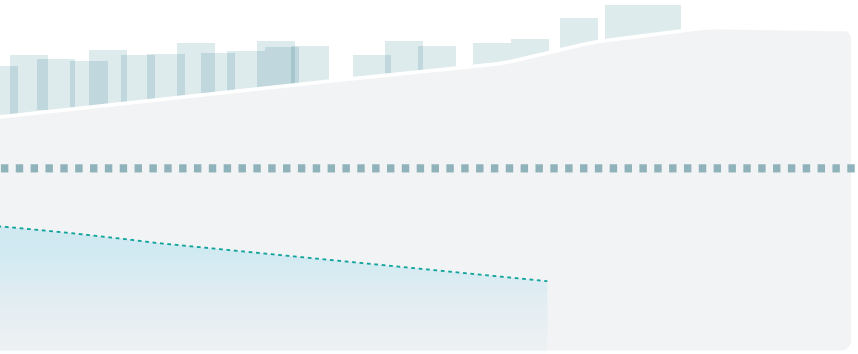
❷ **DELAY + STORE**
SLOPES



❸ **DELAY + RETAIN**
LAHAR SLOPES

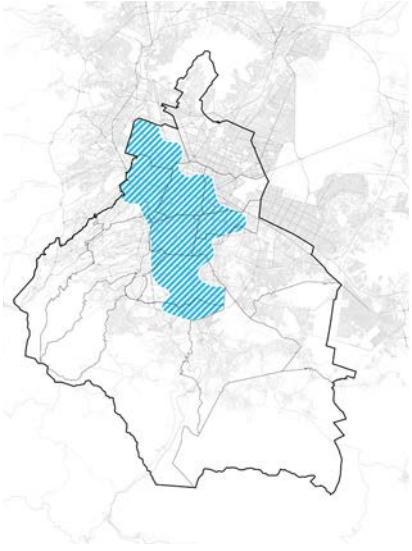
In order to begin restoring the balance within the hydrological cycle of Mexico City via public space interventions we apply the strategy motto: 'Delay, retain, store, reuse and only drain when necessary'. The water balance can be restored, by subsequently applying the most appropriate component of this motto. The strategy is to follow the path of the water from the mountain down into the basin and apply to each step the most effective measure. Up the mountain storing the water to prevent it from running down is most effective. Via this measure the water has time to infiltrate into the aquifer. On the slopes the water should mainly be delayed to prevent flash floods downhill. In the lower basin water should be retained and reused. Mainly in the eastern part of the basin, reusing the water is highly effective because it can be used to substantially green this part of the city and reduce evapotranspiration here.

In the next chapter we will dive deeper into specific sets of measures that go with this overall strategy, per geographical zone. But first we combine the overall public space strategy related to the six different geographical zones, into one conclusive conceptual map for a Water Sensitive Mexico City...

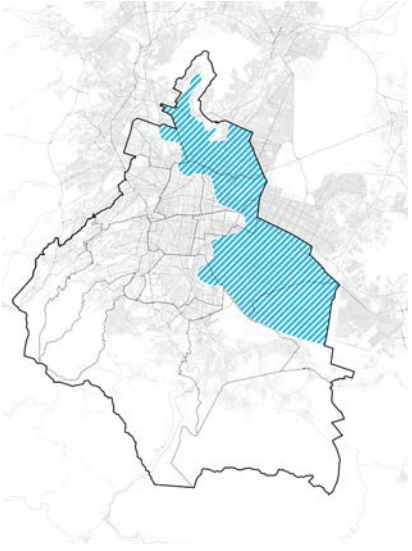


DRAIN
ONLY WHEN NECESSARY

❹ RETAIN + REUSE
WEST BASIN_ ORIGINAL FRESH LAKE



❺ RETAIN + REUSE
EAST BASIN _ ORIGINAL SALTY LAKE



❻ STORE + CLEAN
XOCHIMILCO

WATER SENSITIVE STRATEGY FOR MEXICO CITY

This conceptual strategy map contains the main goals for an effective water management intervention via public space for each of the six geographical zones within Mexico City.

5 *EAST BASIN _ ORIGINAL SALTY LAKE* **RETAIN + REUSE**

4 *WEST BASIN _ ORIGINAL FRESH LAKE* **RETAIN + REUSE**

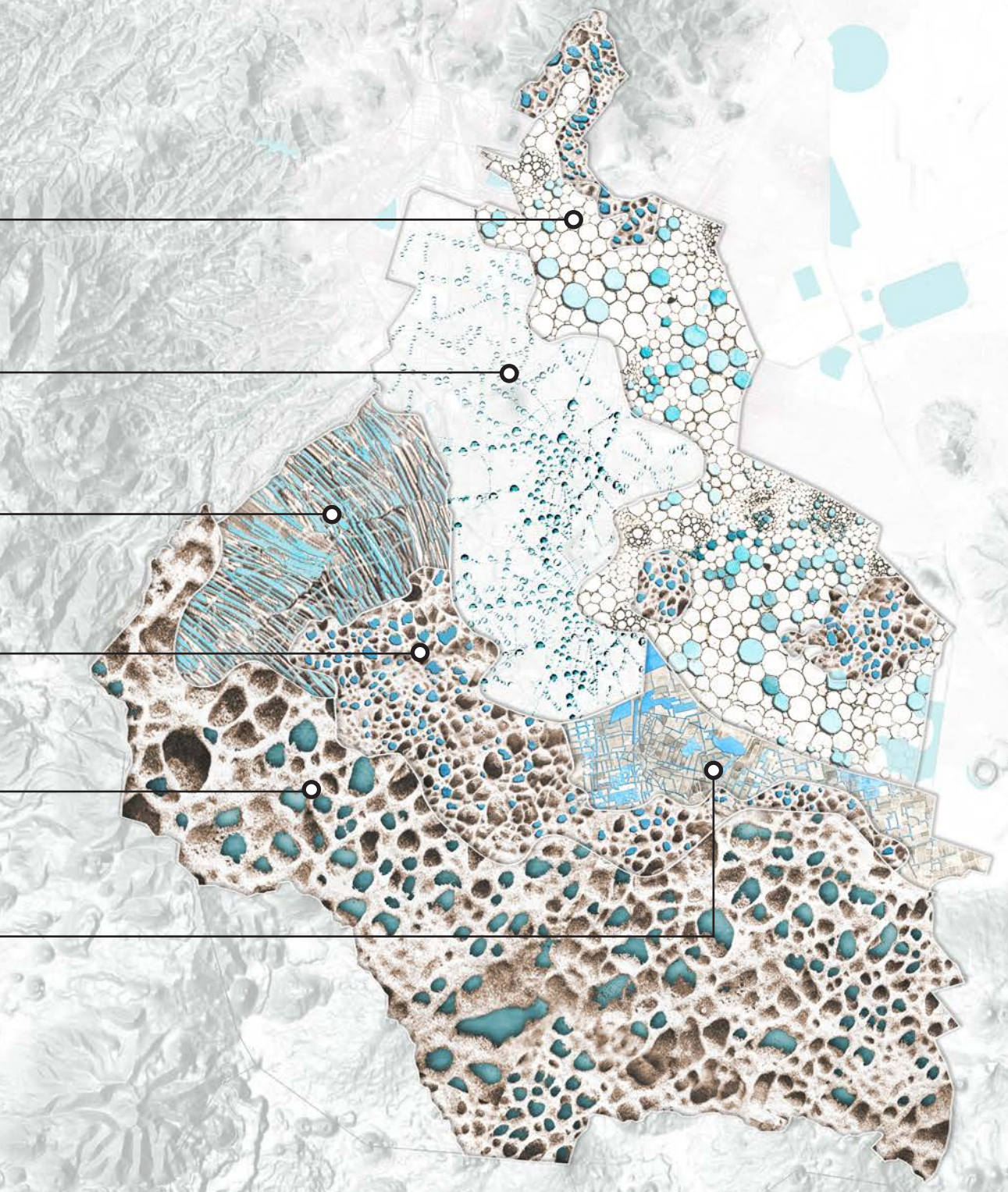
3 *LAHAR SLOPES* **DELAY + RETAIN**

2 *SLOPES* **DELAY + STORE**

1 *VOLCANIC MOUNTAINS* **DELAY + STORE BY INFILTRATION**

6 *XOCHIMILCO* **STORE + CLEAN**

OVERALL WATER SENSITIVE STRATEGY MAP



A CATALOGUE OF WATER SENSITIVE POSSIBILITIES

APPROPRIATE PUBLIC SPACE MEASURES TIED TO DIFFERENT ZONES ON THE MAP

CHAPTER 5

This chapter proposes a number of measures and physical interventions for each of the six zones as they have been defined in the previous chapter. Based on the strategy ‘Delay, retain, store, reuse… ‘ (draining is excluded in this case) a catalogue of possible public space interventions that help to make Mexico City more water sensitive, is defined. We organize them according to the scale of intervention on which we consider them to be most effective from ‘extra-large to small’ size. These applicable measures range from generic large scale statements like seasonal storage facilities to a series of more site specific interventions like the construction of raingardens or water squares.

This toolbox of physical measures is then connected to the water sensitive zoning map of the previous chapter. Per zone a set of appropriate water sensitive measures that address the problem directly, is illustrated with relevant reference project images. In addition to these main measures, other optional measures that can contribute are added. The implementation of measures can be understood as interventions in themselves or as part of a comprehensive urban/ landscape planning strategy.

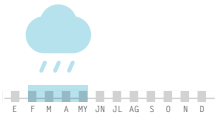
Each zone is represented by a characteristic cut-out from the areal image of Mexico City. They immediately illustrate the differences in urban structure between the six zones.

CATALOGUE OF WATER SENSITIVE POSSIBILITIES

ORGANIZED BY THEIR MOST EFFECTIVE SCALE OF INTERVENTION

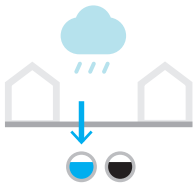
XL

almacenamiento estacional



nuevos canales

separar el sistema de drenaje

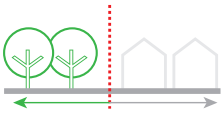


construcción de presas y diques

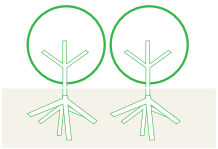
awareness

proteger infraestructuras vitales

limitar zonas urbanizables



smart reforestation



L

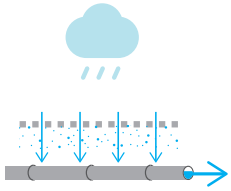
lagunas de retención

revegetar para prevenir la erosión

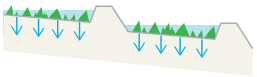
lagunas de retención con infiltración

renaturalización de orillas

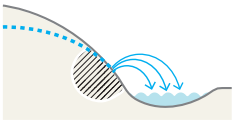
infiltración y alcantarillado de transporte



terrazas de infiltración



crear spacio para agua de manantiales



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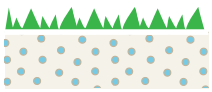

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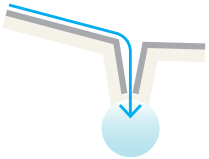
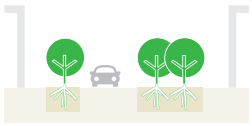


expandir humedales

M

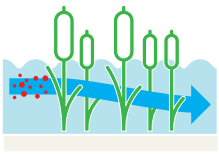
más vegetación en las calles



raingarden

plazas de agua

filtros naturales de purificación de agua



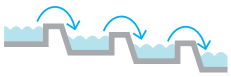
bioswales

waterstreets

reducción de zonas pavimentadas

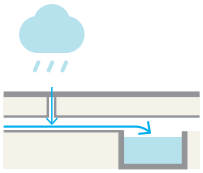
pavimento poroso

diques en cascada

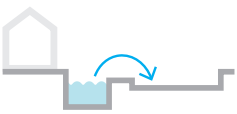


huertos urbanos

tanques de almacenamiento



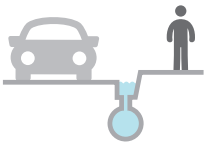
areas de retención urbanas



S

tanques de agua de lluvia

creación de acequias



ajustar el perfil de las calles

franja de infiltración

** The intervention size does not relate to overall effectiveness. Many small measures can have a big impact.*

ZONE 1

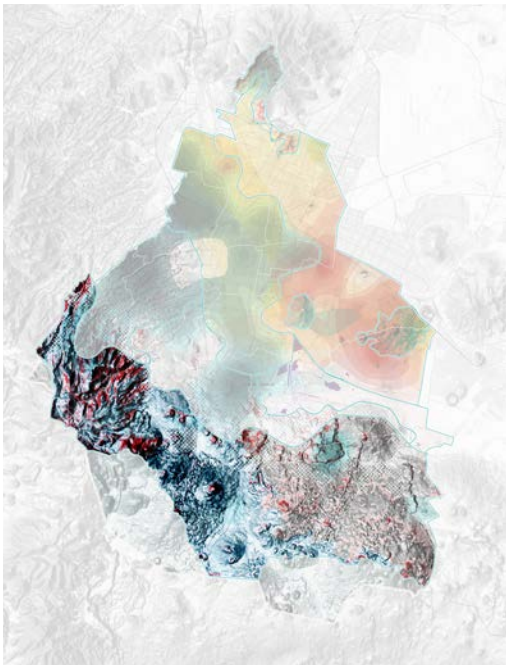
DELAY + STORE (AND INFILTRATE)

VOLCANIC MOUNTAINS_CONSERVATION AREA

The objective of the conservation area for a water sensitive Mexico City would be to maximize rainwater storage to have as much water infiltration as possible here. This largely unbuilt area has great infiltration potential thanks to the porous structure of the volcanic rock. Because of past deforestation of the slopes, large volumes of water run off the mountain without being delayed, rendering areas downhill at risk and vulnerable.

The goal should be to delay the rain water and store it temporarily on the mountain and its slopes so it can infiltrate fully via the volcanic rock into the deeper layers of the aquifer below the urbanized basin of the city. Appropriate measures would be to construct dikes, dams and terraces in order to store the water on the mountain sides. All this can only be effective if further urbanization of this natural area is prevented and reforestation is undertaken instead.

Interestingly enough the areas with the highest potential to recharge the aquifer, overlap with the environmental units of protection, conservation and restoration in the official Conservation Area.



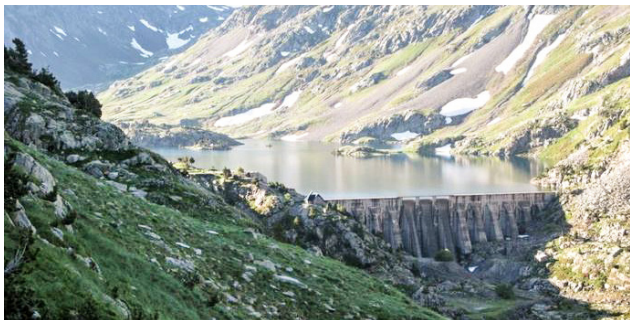
RISK *RUN OFF STREAMS*

Water Sensitive Strategy

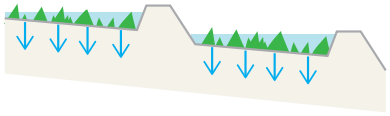
Maximize the optimal use of the existing sponge characteristics of this zone

MAIN MEASURES

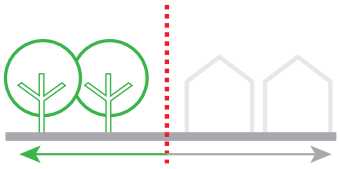
CONSTRUCCIÓN DE
PRESAS Y DIQUES

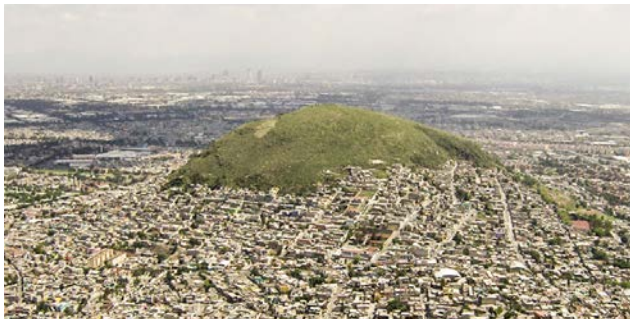


TERRAZAS DE INFILTRACIÓN



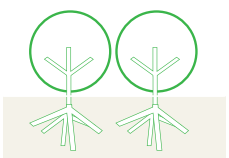
RESTRINGIR URBANIZACIONES





OPTIONAL MEASURES

smart reforestation



Lagunas de retención
con infiltración

ENVIRONMENTAL MANAGEMENT UNITS OF THE CONSERVATION AREA AND AQUIFER RECHARGE

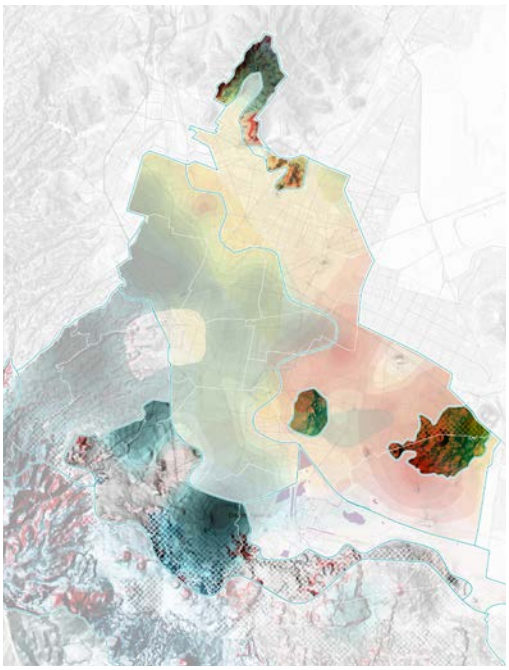
The areas with highest potential to recharge the aquifer, overlap with the environmental units of protection, conservation and restoration areas in the *Conservation Area.*

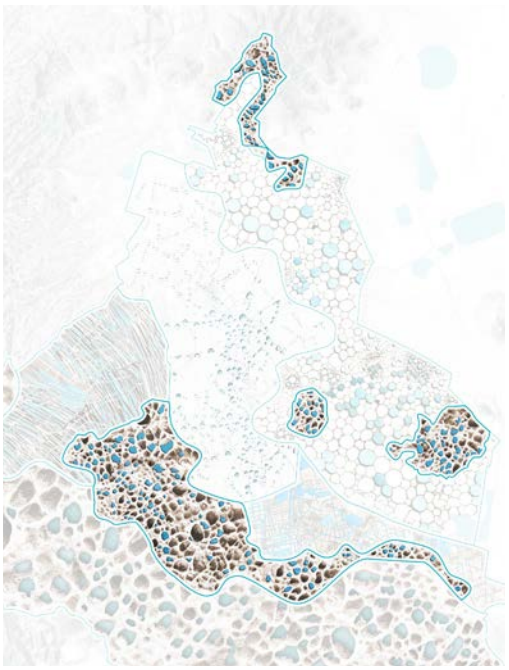
source : Propuesta de modelo para el manejo del SCDF_ATLAS GEOGRÁFICO DEL SUELO DE CONSERVACIÓN DEL DISTRITO FEDERAL, Dirección de Ordenamiento Ecológico del Territorio y Manejo Ambiental del Agua, Secretaría del Medio Ambiente y Universidad Autónoma del Estado de Morelos

ZONE 2
DELAY + STORE
SLOPES_SOUTH, EAST, NORTH

The objective of the slopes would be to minimize the speed and amount of rain runoff to prevent flash floods downhill. The slopes form the transition area between the mountains and the low lying urbanized basin. Water that runs off the mountain slopes is hardly being slowed down here, since large parts of these slopes are becoming more and more (partly illegally) urbanized. The increase of impermeable pavement only accelerates the water even more downhill.

Main measures are aimed at decreasing the speed of the water by small dams or natural obstacles and to temporarily retain the water in public space. The goal is to give it time to infiltrate in a natural way, for example, supported by natural purification and infiltration areas. These areas can become attractive spaces that help to clean the water that will be polluted by flowing over urbanized surfaces. After cleaning, it can sink into the porous rock and replete the aquifer.





RISK

FLASH FLOODS

EVAPOTRANSPIRATION + SOIL SALINITY

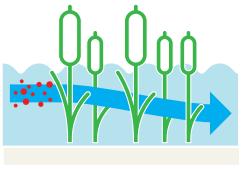
Water Sensitive Strategy

Maximize the sponge qualities by slowing the water down (delay) and creating more open water surface.

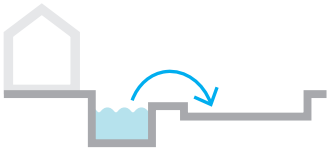
MAIN MEASURES

LAGUNAS DE RETENCIÓN CON INFILTRACIÓN

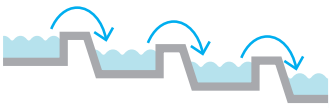
FILTROS NATURALES DE PURIFICACIÓN DE AGUA



AREAS DE RETENCIÓN URBANA



DIQUES EN CASCADA

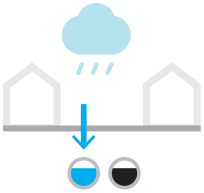


RENATURALIZACIÓN DE ORILLAS

OPTIONAL MEASURES

bioswales

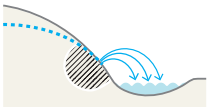
separar sistema de drenaje



waterstreets

awareness

crear spacio para agua de manantiales



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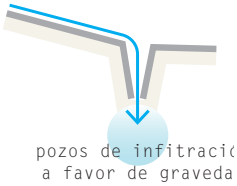


pozos de infitraci
a favor de graveda

franja de infiltración

reducción de zonas pavimentadas

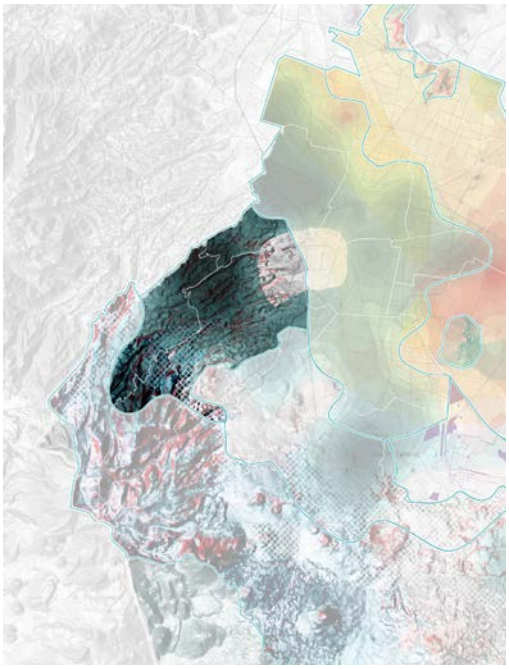
más vegetación en las calles

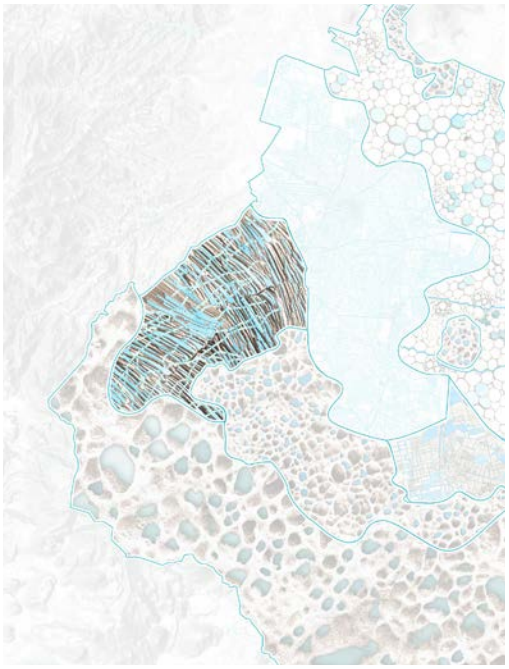
proteger infraestructuras vitales

ZONE 3
DELAY + RETAIN
LAHAR SLOPES_WEST

The objective of the Lahar slopes would be to minimize the speed and amount of rain runoff to prevent flash floods downhill just like the previous zone. Even though these western slopes have the same type of risks as the previously described slopes, the negative effects are more severe caused by more intense urbanization in combination with an unstable geological base. The runoff is concentrated in a few lines of water that can reach extremely dangerous speeds, causing high risks for landsides.

It is important here to take into account the instability of the geological base that causes these landslides when flash floods occur. The main measures to be taken have the function to temporarily retain and substantially delay the speed of the water. Since this is one of the most heavily urbanized and paved areas of the city, the measures will have to be more robust and technical in order to be effective. After slowing down the runoff, the water could be reused or drained.





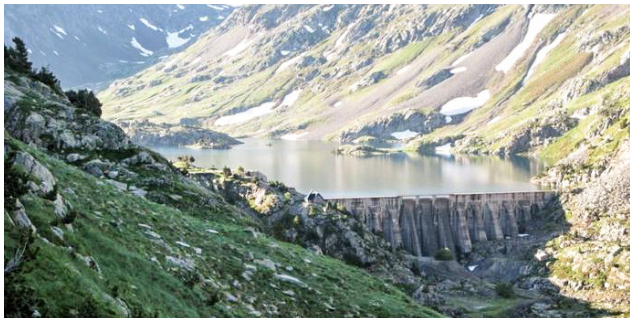
RISK *FLASH FLOODS*

Water Sensitive Strategy

Slow the water down and hold it for a while to release it at slow pace.

MAIN MEASURES

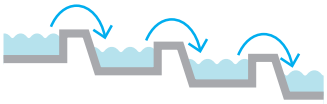
CONSTRUCCIÓN DE PRESAS Y DIQUES



REDUCCIÓN DE ZONAS PAVIMENTADAS

REVEGETAR PARA PREVENIR LA EROSIÓN

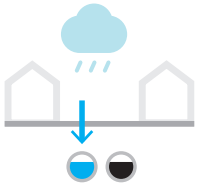
DIQUES EN CASCADA



OPTIONAL MEASURES

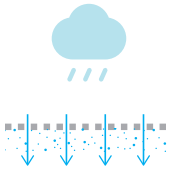
bioswales

separar sistema de drenaje



más vegetación en las calles

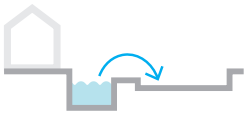
pavimento poroso



lagunas de retención

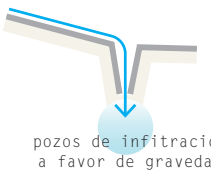
waterstreets

areas de retención urbanas



ajustar el perfil de las calles

pozos de infitración a favor de gravedad



awareness

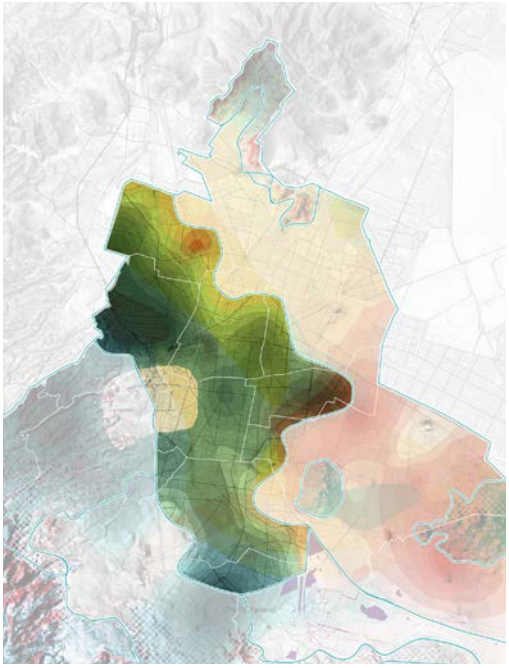
proteger infraestructuras vitales

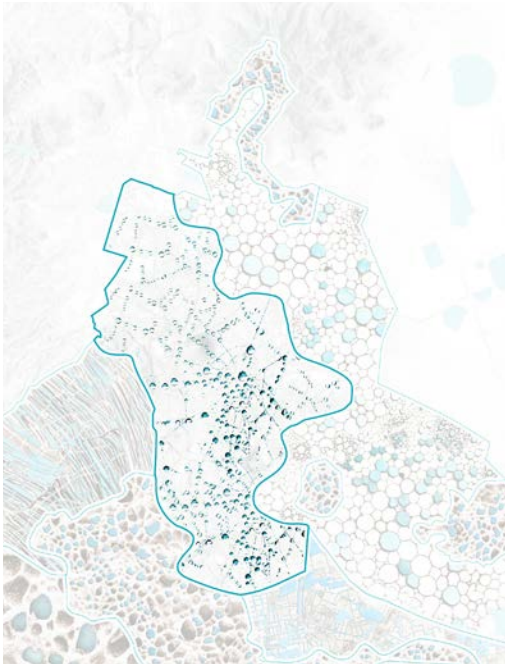
ZONE 4
RETAIN + REUSE
WEST BASIN_ORIGINAL FRESH WATER LAKE

The objective of the western part of the basin is two-sided: preventing the negative effects of flooding as well as drought. The part of the city where the original freshwater lake was situated perfectly represents the current paradox of Mexico City's relationship with its water. Here flooding problems related to heavy rains and drought problems caused by a lack of water and strong heat waves overlap.

The main interventions have to capture the water in times of heavy rainfall and reuse the water in the dry periods. Since this is the oldest urbanized area of the city with the highest population density , there is limited space to apply these measures. Large retention areas and storage basins are not applicable here. Instead a refined series of interventions that can fit into the dense urban fabric should be put in place, ranging from floodable infrastructure to water squares, from road side bioswales to lush green raingardens. This contextual approach will lead to a small scale network of public spaces that can retain heavy rain and store water for reuse in dry periods. Moreover, these spaces reinforce their context and offer a diversity of urban uses as well.

Another function of the public presence of water dynamics in the city, is creating a more common awareness around the importance of good use of this scarce resource.





RISK

EXCESS AND LACK OF WATER ASSOCIATED PROBLEM

HEAT WAVES

Water Sensitive Strategy

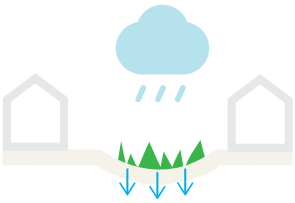
Retain the drops of water on the surface to release at slow pace for reuse or drainage

MAIN MEASURES

WATERSTREETS

PLAZAS DE AGUA

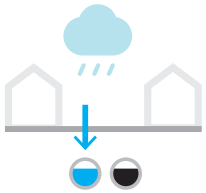
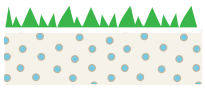
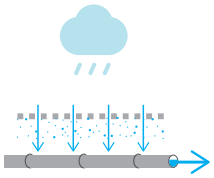
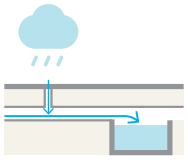
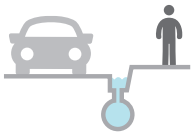
BIOSWALES



RAINGARDENS

AWARENESS

OPTIONAL MEASURES

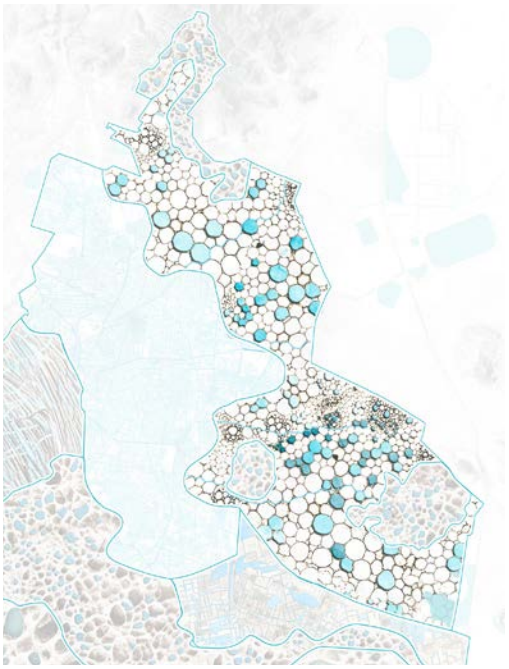
separar el sistema de drenaje	suelos eponja	pavimento poroso	infiltración y alcantarillado de transporte
			
almacenamiento estacional	más vegetación en las calles	reducción de zonas pavimentadas	tanques de almacenamiento
			
tanques de agua de lluvia	ajustar el perfil de las calles	creación de acequias	proteger infraestructuras vitales
			

ZONE 5
RETAIN + REUSE
EAST BASIN_ORIGINAL SALTY LAKE

The objective of the eastern part of the basin, where the original salt water lake was situated, is focussed on fighting drought. Here an accumulation of problems related to heat waves, high evapotranspiration and a lack of drinking water occurs. High levels of water extraction lead to alarming levels of subsidence.

The main measure here is retaining and storing water that falls in the rainy season in order to reuse it in the long dry period. Since this part of the city has a lot of open spaces with little high quality public space, interventions can be done to intensify green infrastructure here. This could lower evaporation rates and offer local cooling. That will not however not be enough . Soil improvement in combination with underground storage tanks will be needed to provide enough water to establish and maintain a substantial and sustainable greening of this part of the city.

This reuse of water can also be done by private individuals or local communities in order to be less dependent on official water supplies and reduce groundwater extraction and subsequent subsidence. Just like in the western basin, the tangible presence of water dynamics helps to create a common awareness of the importance of good use of this scarce resource.



RISK

EVAPOTRANSPIRATION + SOIL SALINITY

HEAT WAVES

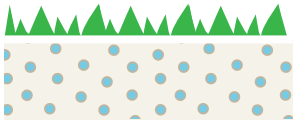
LIMITED DRINKING WATER PROVISION

Water Sensitive Strategy

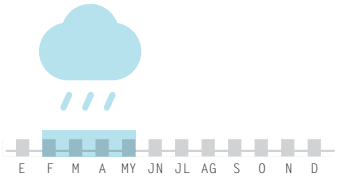
Retain the water to store it for reuse in dry periods. Create closed local water cycles.

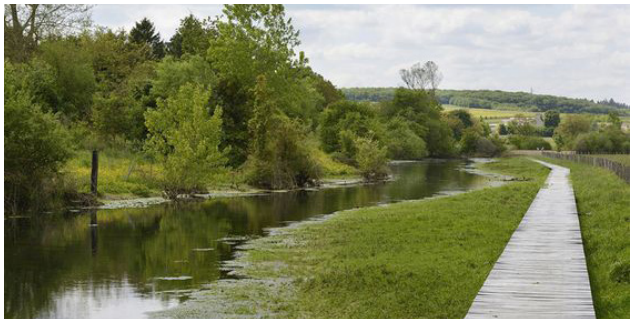
MAIN MEASURES

SUELOS ESPONJA

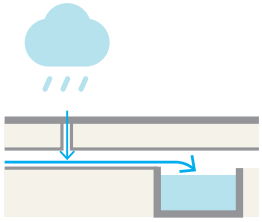


ALMACENAMIENTO ESTACIONAL

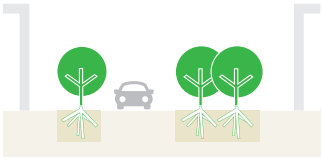




TANQUES DE ALMACENAMIENTO



MÁS VEGETACIÓN EN LAS CALLES

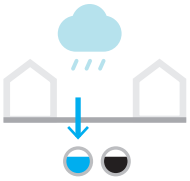


TANQUES DE AGUA DE LLUVIA

OPTIONAL MEASURES

waterstreets

separar sistema de drenaje



ajustar el perfil de las calles

bioswales

awareness

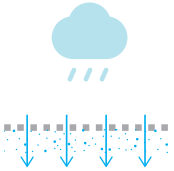
huertos urbanos

renaturalización de orillas

plazas de agua

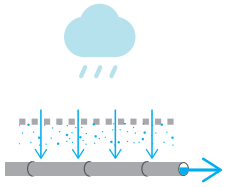
reducción de zonas pavimentadas

pavimento poroso

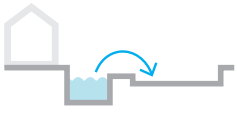


lagunas de retención

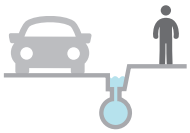
infiltración y alcantarillado de transporte



areas de retención urbanas



creación de acequias



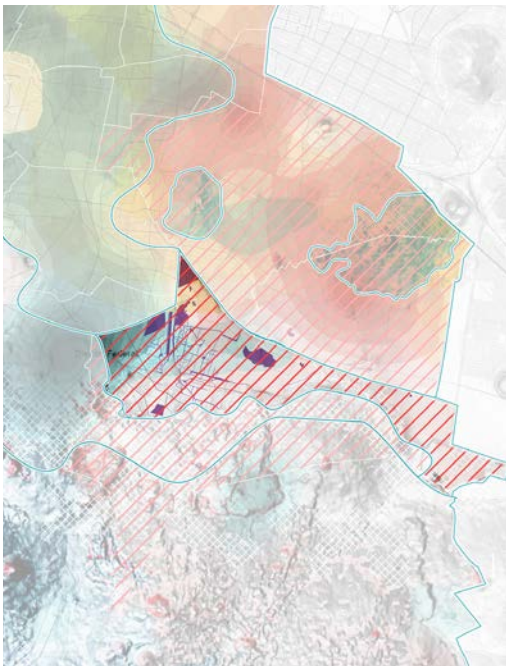
proteger infraestructuras vitales

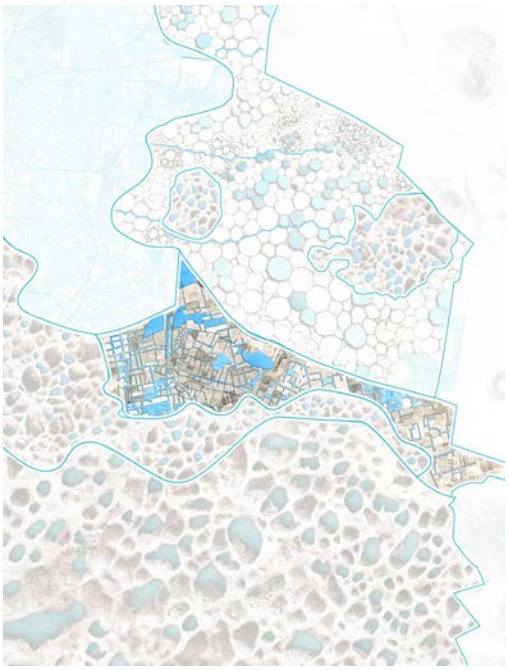
ZONE 6
STORE (AND CLEAN)
XOCHIMILCO

The objective of the Xochimilco is to save and restore a highly valuable cultural heritage. This area is the last ancient agricultural landscape within Mexico City that shows the original Aztec way of life and expresses a harmony between the city and its water. Currently this ecological zone is pressured by illegal urban settlements dumping their sewage waste water into the vulnerable system of lakes and channels. The availability of clean water is a serious problem. This overlaps with problems associated with flood risks and lack of water. In rainy periods the water is drained out of the area and in dry periods there is a lack of water.

Main measures include improving water quality by implementing a basic sewerage infrastructure, expanding the surface of lakes and canals to maximize seasonal storage and increasing the amount of hectares of conservation area under ecological and cultural protection. Because of the historical, cultural, ecological and recreational importance of Xochimilco, this area warrants being a showcase on how to deal with water in a sustainable way. For this purpose additional measures could be implemented like natural cleaning systems in combination with existing open water structures and opening pressure wells that are located at the foot of the mountains and spray clean water into open water bodies.

Because of its recreational popularity, a tangible presence of water dynamics in Xochimilco helps to create more common awareness of the importance of good use of water as a scarce resource.





RISK

POLLUTED WATER

LIMITED DRINKING WATER PROVISION

Water Sensitive Strategy

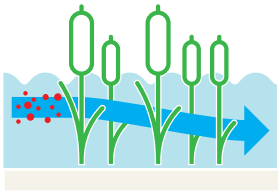
Create more open water connections and decrease pollution by instaling sewerage infrastructure.

MAIN MEASURES

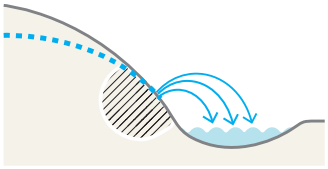
NUEVOS CANALES

AWARENESS

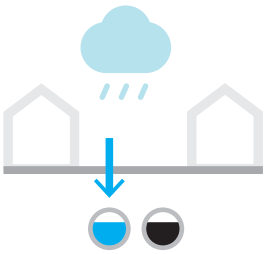
FILTROS NATURALES DE PURIFICACIÓN DE AGUA



CREAR SPACIO PARA AGUA DE MANANTIALES



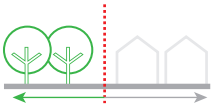
SEPARAR SISTEMA DE DRENAJE



OPTIONAL MEASURES

lagunas de retención con infiltración

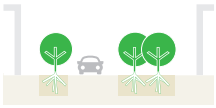
limitar zonas urbanizables



ajustar el perfil de las calles

waterstreets

calles más verdes



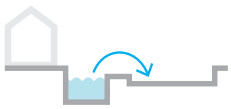
renaturalización de orillas

almacenamiento estacional

reducción de zonas pavimentadas

bioswales

areas de retención



expandir humedales

huertos urbanos

proteger infraestructuras vitales

SEVEN + ONE WATER SENSITIVE PUBLIC SPACES

ELABORATION OF MEASURES INTO CONCEPTUAL DESIGN TYPOLOGIES

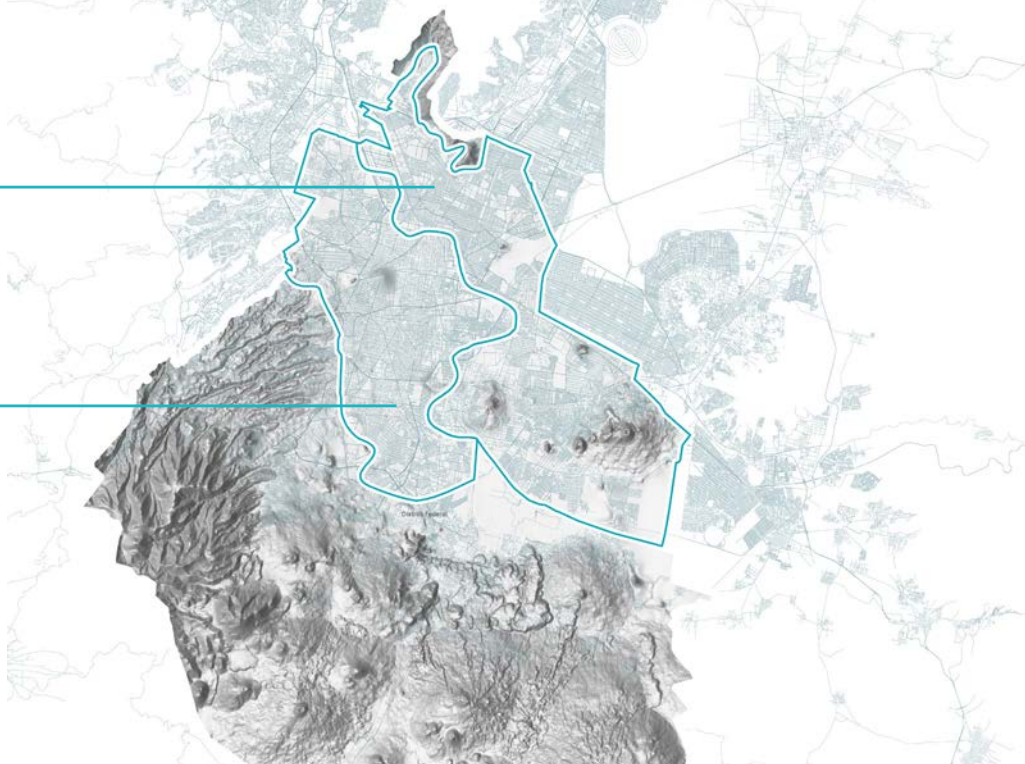
CHAPTER 6

In this chapter the measures of the previous chapter are connected to and translated into conceptual design typologies on site in Mexico City. We will focus on the areas most relevant for AEP-intervention: the Central city and Iztapalapa. Both these areas can be connected to different water sensitive zoning as it has been explained in the previous chapters. The Central city is covered by the western basin (zone 4) and Izapalapa is covered by the eastern basin (zone 5). Each of the two zones represents a different water sensitivity goal and both zones differ substantially in the spatial characteristics of their urban fabric.

In the western basin the water sensitive approach is focused on retaining water and then reusing it as much as possible. This area has a high density urbanization, its public space is scarce but overall is of high quality. Here a refined series of interventions that can fit into the dense urban fabric should be placed. A contextual approach can lead to a small scale network of public spaces that can retain heavy rain and at the same time reinforce their context and offer a diversity of urban uses.

In the eastern basin the main goal is to reuse the water which will be preceded by seasonal storage. Since this part of the city has a lot of open spaces with little public space quality, interventions should be done to intensify high quality green infrastructures. This can lower evaporation rates and offer local cooling. Soil improvement in combination with underground storage tanks will be needed to provide enough water to establish and maintain the substantial and sustainable greening of this part of the city.

In both areas, four different types of representative public spaces are being dealt with. This has been done by designing an prototypical section for each of the public space typologies. This exemplary section design is meant to illustrate a fruitful combination between smart water management and quality public space fit for active urban use.

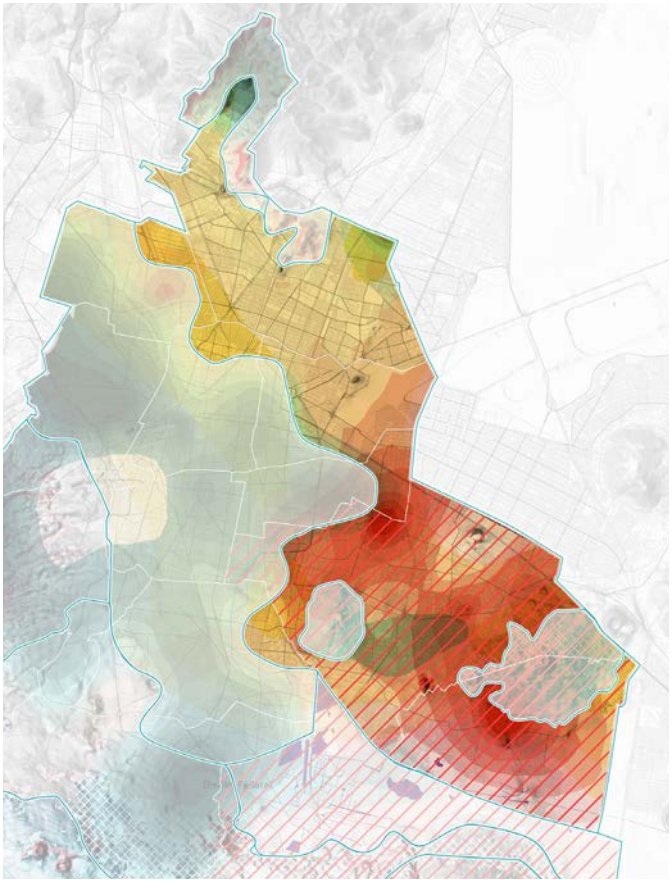


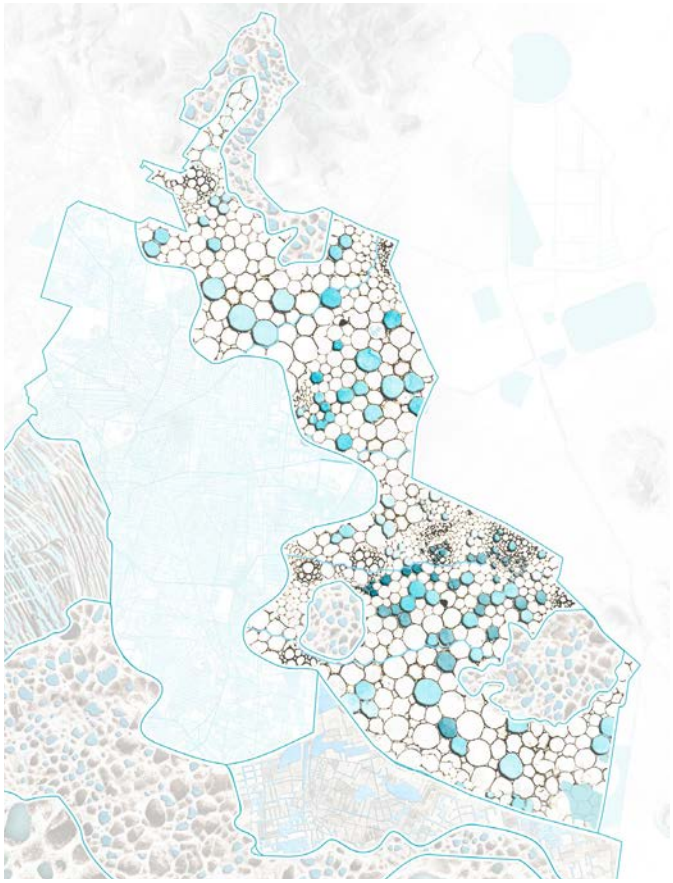
PUBLIC SPACE TYPOLOGIES TO REUSE WATER

EAST BASIN_ORIGINAL SALTY LAKE

In this zone the lack of water is urgent and therefore reusing rain water is the main goal. To do this seasonal storage of water for dry periods is needed. Draining the water is highly undesirable in this zone. This area is relatively spread out and not densely populated. The pressure on vehicular infrastructure is high since many people depend on it. This area is very dry, has little well maintained public space and many residual spaces without clear function or quality. We distinguish four different types of exemplary public space typologies that can be turned into a water sensitive public space and can also help raising public awareness:

- Communal spaces can become lush green urban oases
- Medians can be designed as blue-green corridors for sport and play
- Oversized streets have left over spaces which can be turned into linear parks
- Wastelands could gradually turn into large scale cleaning parks





RISK

EVAPOTRANSPIRATION + SOIL SALINITY

HEAT WAVES

LIMITED DRINKING WATER PROVISION

Water Sensitive Strategy

Retain the water to store it for reuse in dry periods. Create closed local water cycles.

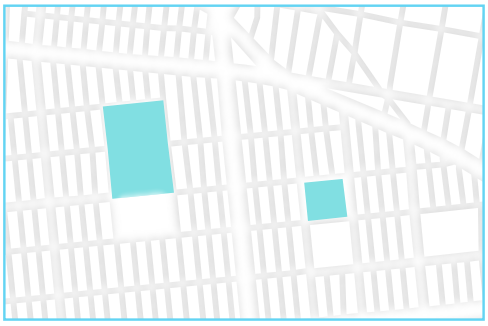
URBAN WATER SENSITIVE TYPOLOGIES

Schematic interpretation of the urban fabric of the eastern urbanized basin, illustrating the impact of different Water Sensitive public space typolgies.

1 COMMUNAL SPACES

→

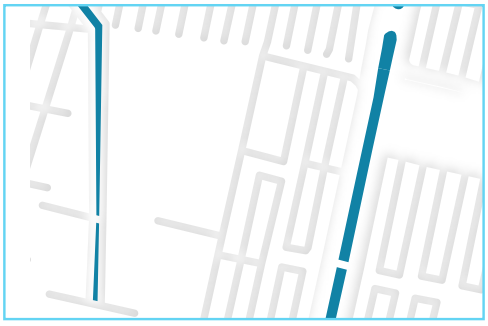
URBAN OASIS



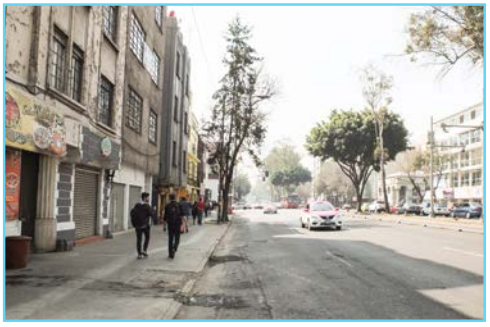
2 MEDIANS

→

BLUE-GREEN CORRIDOR

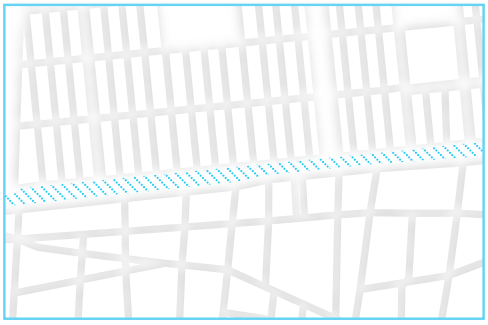


3 OVERSIZED STREETS



→

LINEAR PARK



4 WASTELANDS

→

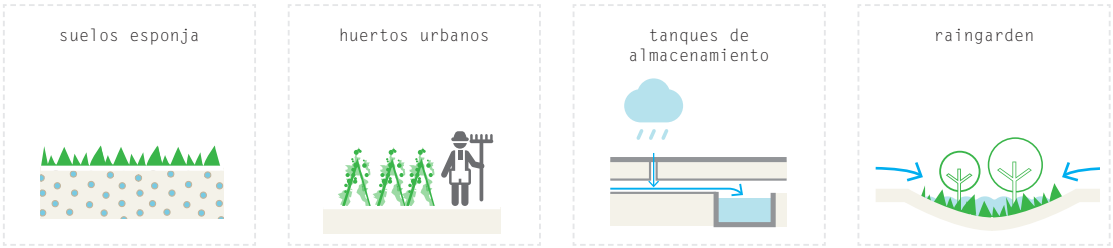
CLEANING PARK

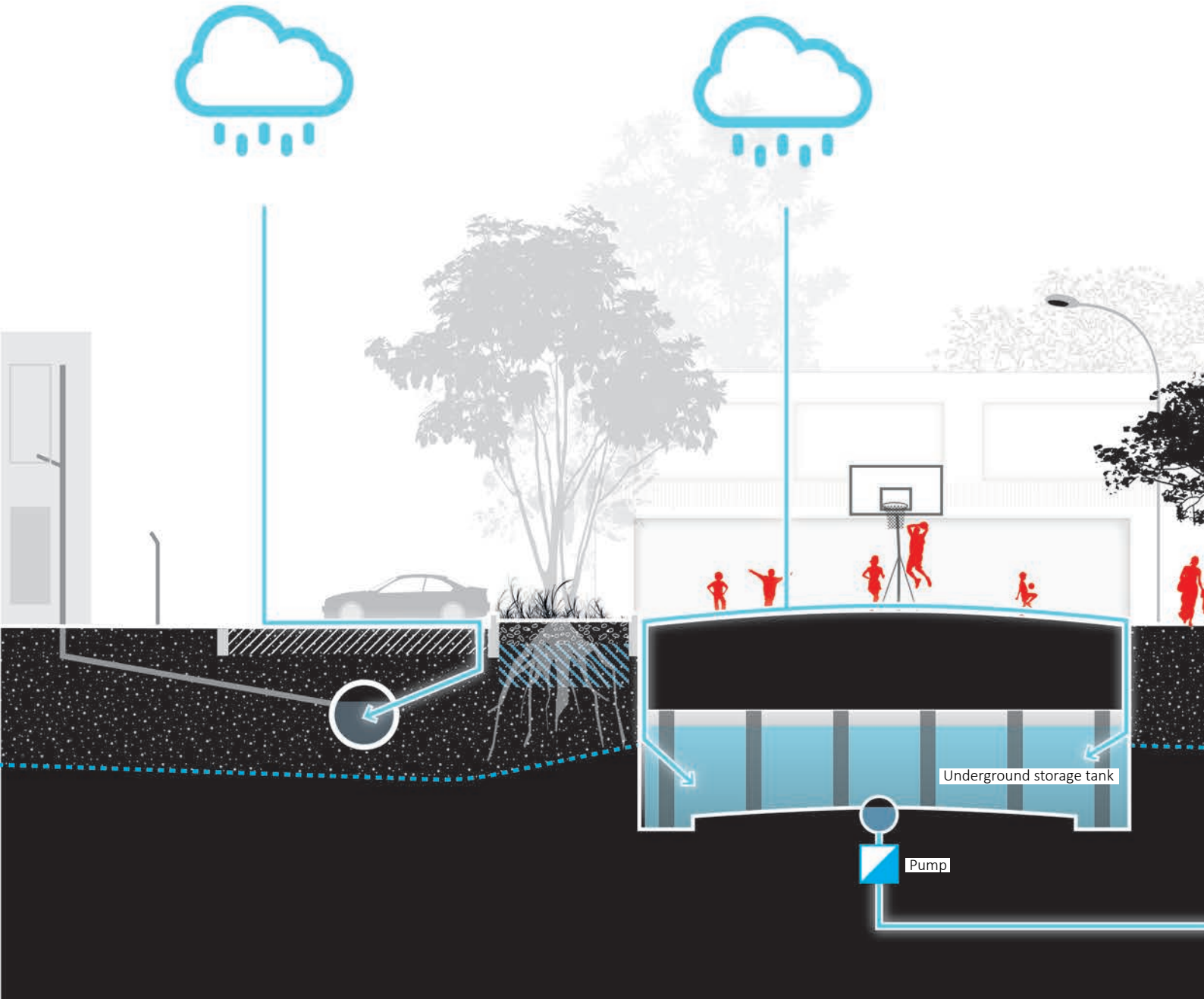
TYPOLOGY 1

TRANSFORMING COMMUNAL SPACES INTO URBAN OASIS

Dry open places in the heart of the community are uploaded with technical measures like a subterranean storage tank and spongey soil capable of holding water more efficiently. Rain water will be retained and stored in these facilities so they can be reused and led along a lush green urban oasis that reduces evaporation and cools during hot days. The shady places are better capable of holding water and keeping soil moist, thus reinforcing their storage potential. The green spaces can function as rain gardens offering cool places for relaxation. Playgrounds and adjacent roofs can retain water and lead it into storage facilities. This water can be used to maintain the green oasis and additional community facilities such as urban farming.

APPLICABLE MEASURES

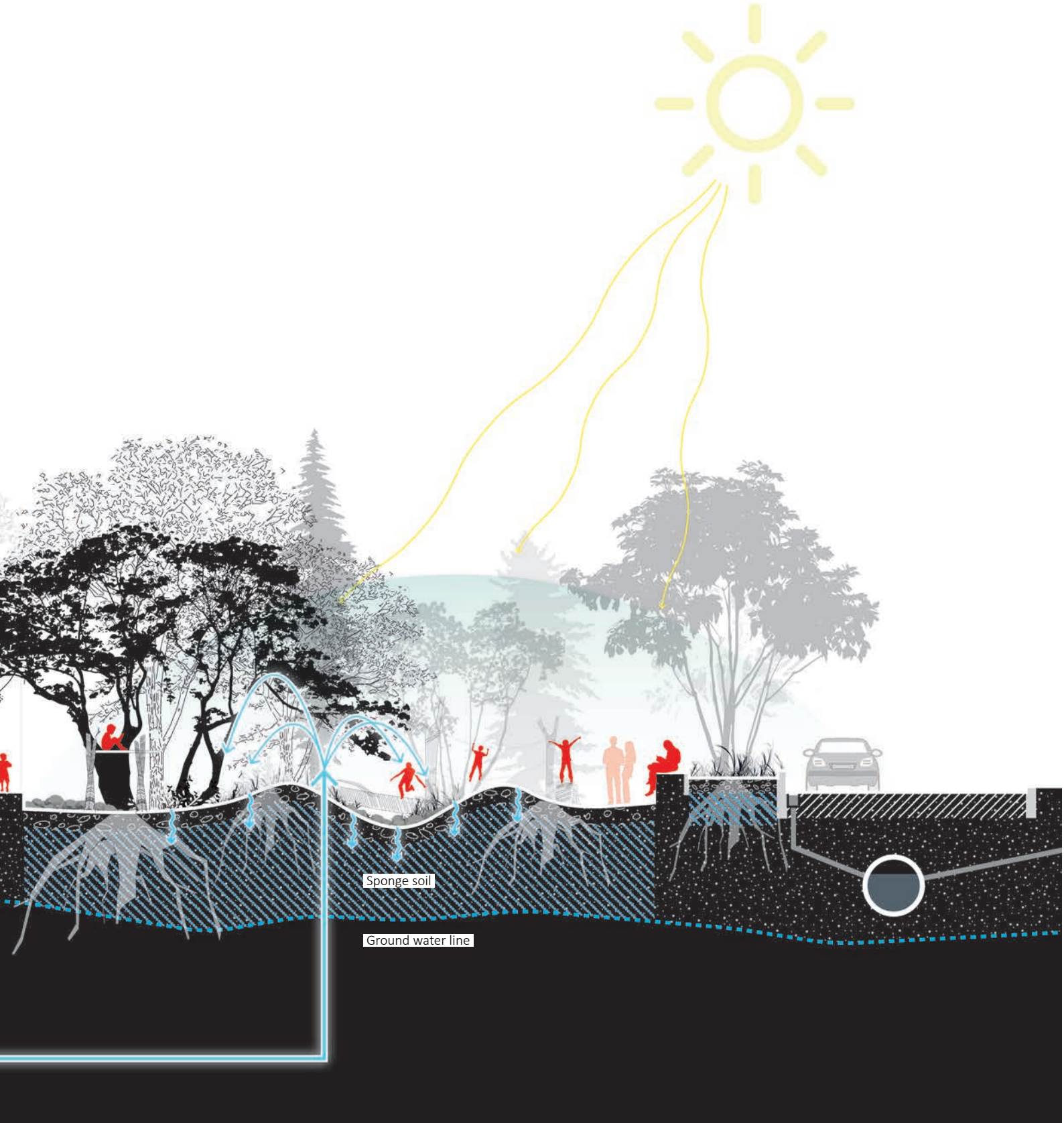




APPLICABLE ZONE

APPLICABLE TYPOLOGY

EXAMPLE PICTURE

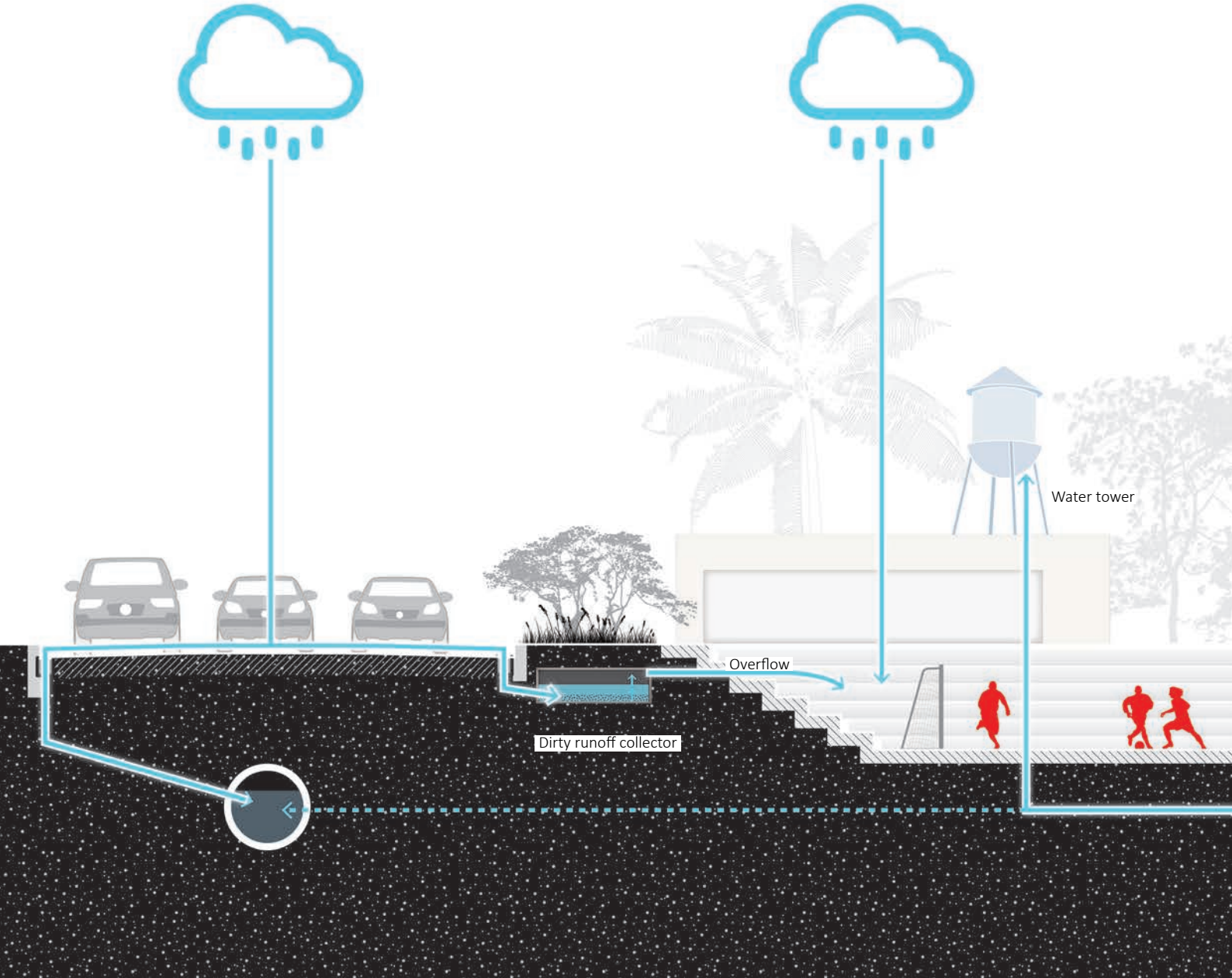


TYPOLOGY 2

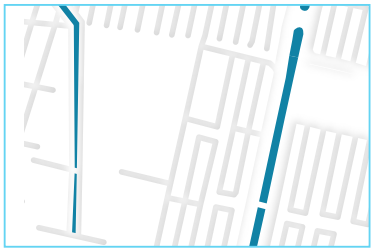
TRANSFORMING MEDIANS INTO GREEN-BLUE CORRIDORS

The hard spaces in between large scale vehicular infrastructure called ‘medians’ can be designed as blue-green corridors. Here rain water can be led to be filtered and reused to irrigate tree structures. This green infrastructure provides shade and local cooling for sport and play facilities that are situated here. These active facilities can be designed in such a way that they also offer retention space for heavy rain events. They can deliberately flood to free the car infrastructure from hindrance and danger. After rain events this water should be filtered and preferably stored for local reuse. The required height differences necessary for water retention are extra suitable for lingering and play activities in a dry periods.

APPLICABLE MEASURES

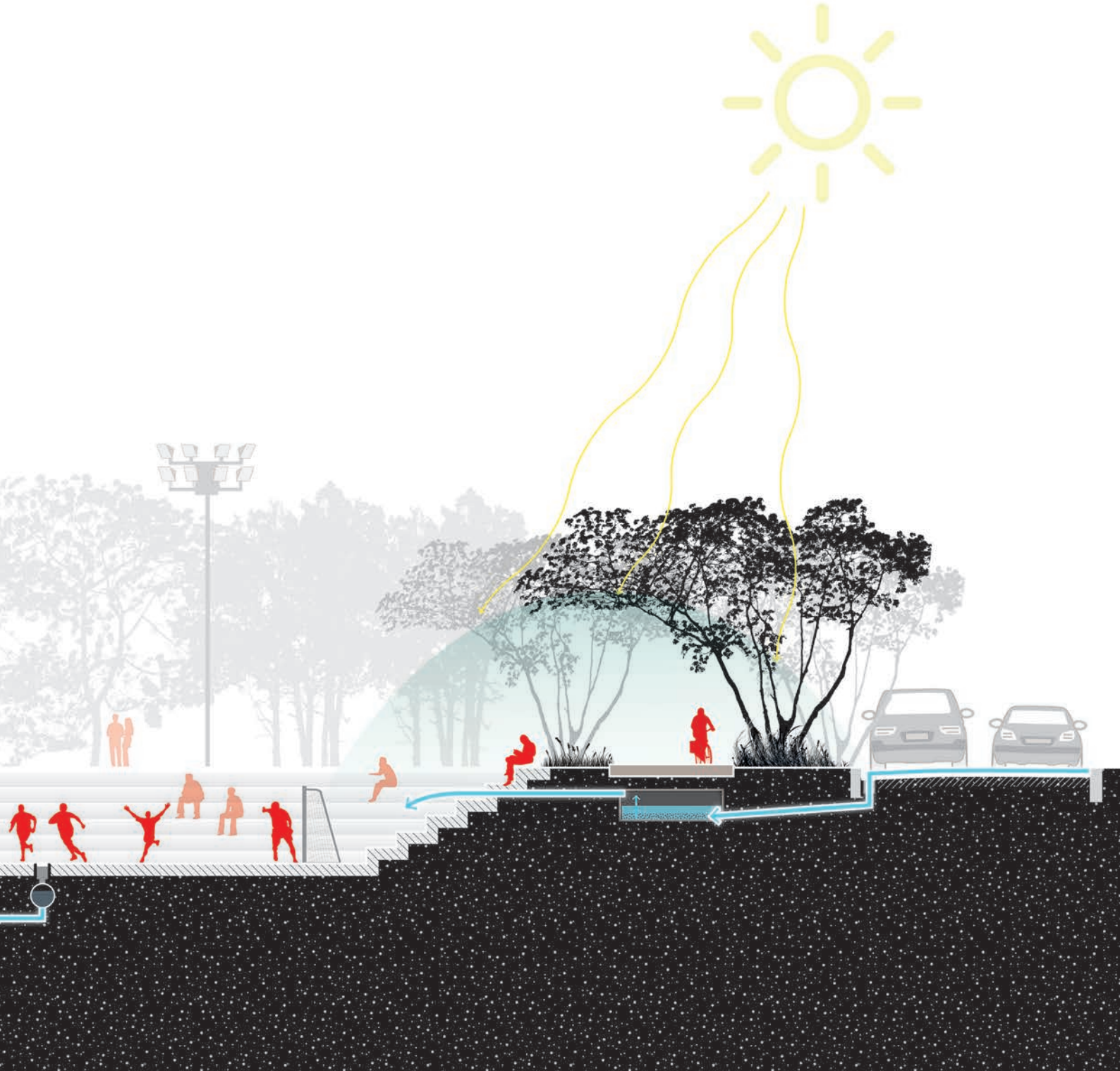


APPLICABLE ZONE



APPLICABLE TYPOLOGY

EXAMPLE PICTURE

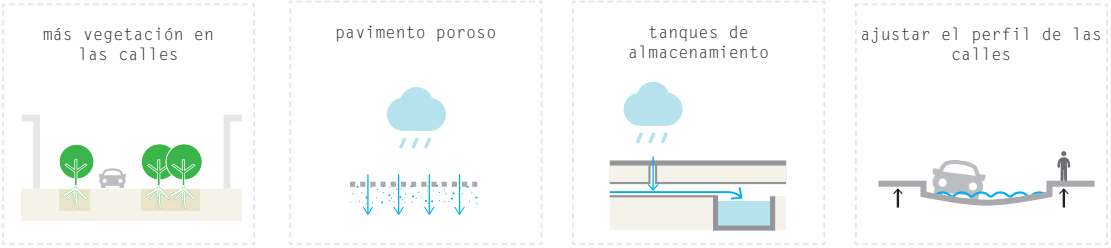


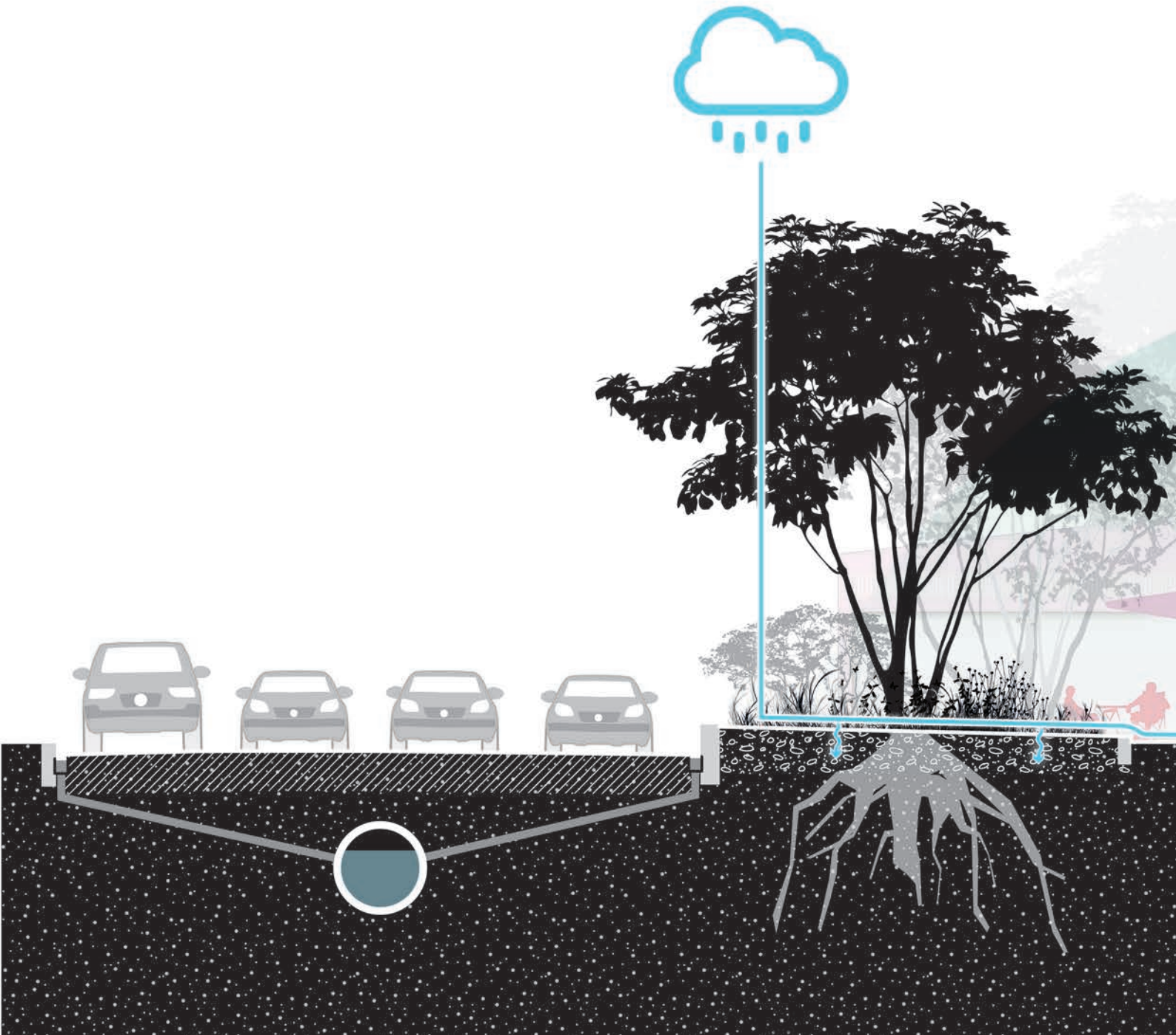
TYPOLOGY 3

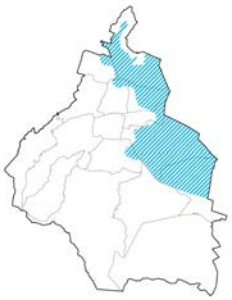
TRANSFORMING OVERSIZED STREETS INTO LINEAR PARKS

Oversized streets can also be transformed into substantially greener structures like linear parks. Here water collection can happen locally in storage tanks, to be reused on site to hydrate trees or in a more playful way as fountains for play. Additional filtering will be needed here. The advantage of a linear park is that it touches a long stretch of urbanized area and can have a high community value because of its accessibility and potential to raise awareness.

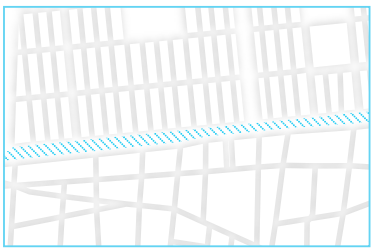
APPLICABLE MEASURES



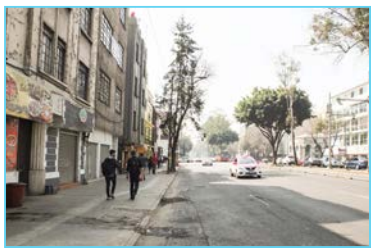




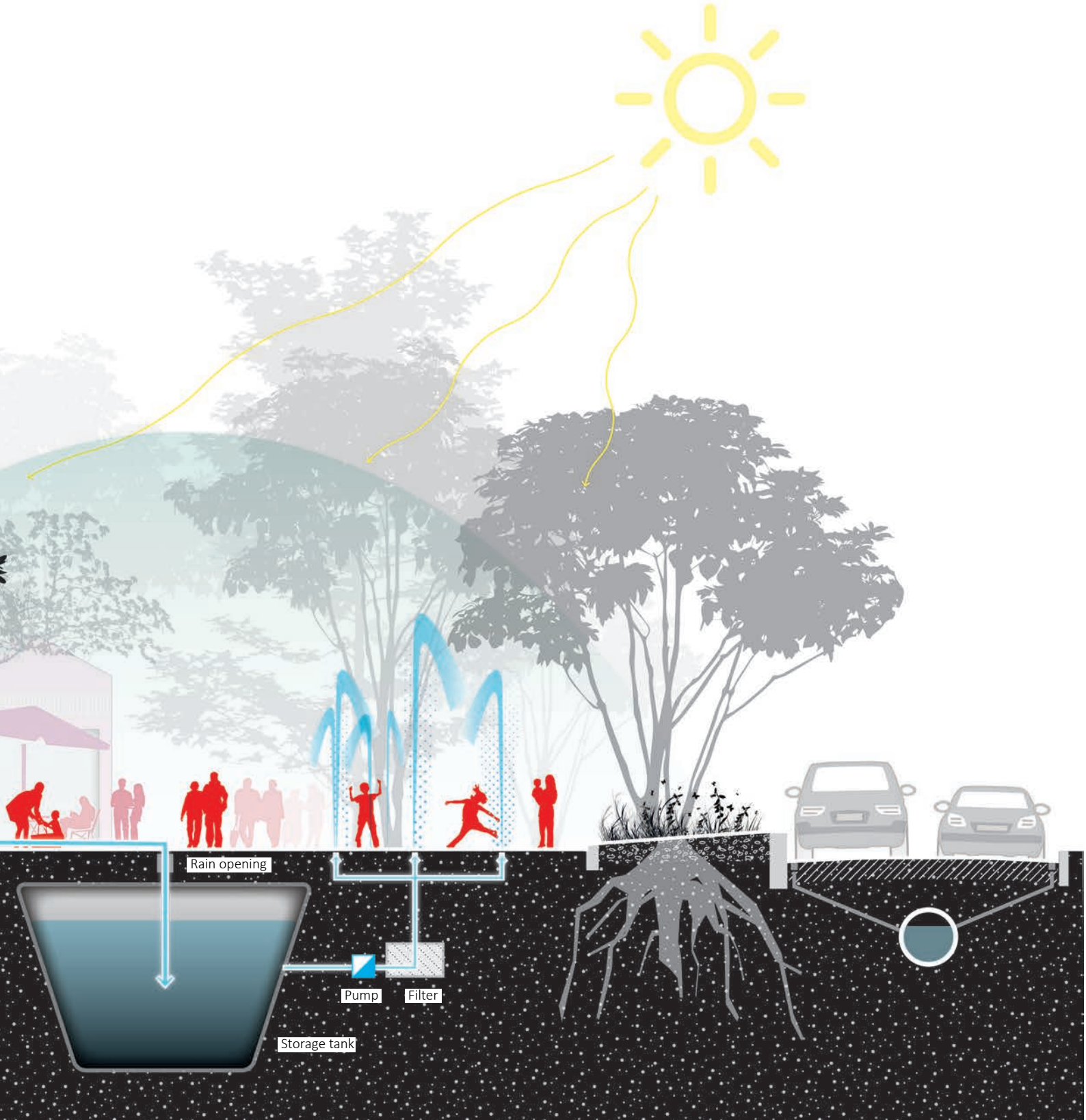
APPLICABLE ZONE



APPLICABLE TYPOLOGY



EXAMPLE PICTURE



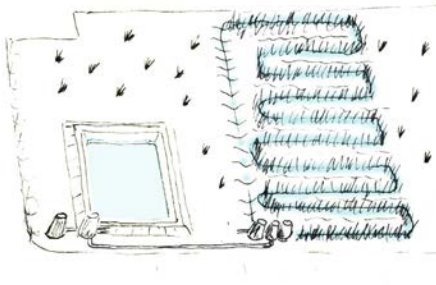
TYPOLOGY 4

TRANSFORMING WASTELANDS INTO CLEANING PARKS

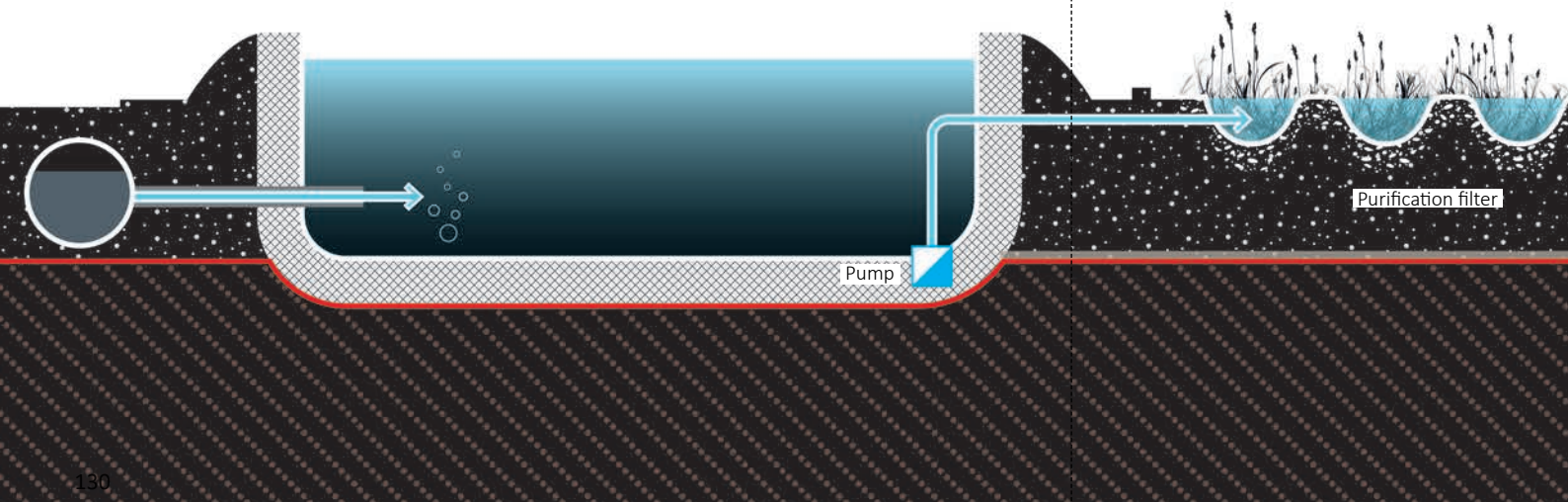
Large chunks of unused land and former landfills are wastelands that could be put to use again. They could gradually turn into large scale cleaning parks. In a first phase a large retention basin could be put into place here to serve a singular purpose as flood prevention facility. In this stage the place would not be accessible for the public. In a second stage the polluted water could be lead through an extensive open air green cleaning facility that gradually cleans the water up to a level that it can be opened for limited public use. In the third stage the clean water can be stored in a newly created lake, that also functions as a seasonal storage basin. Urban recreation could potentially happen here, in combination with attractive real estate development (with lake view).

APPLICABLE MEASURES

FIRST PHASE



SECOND PHASE

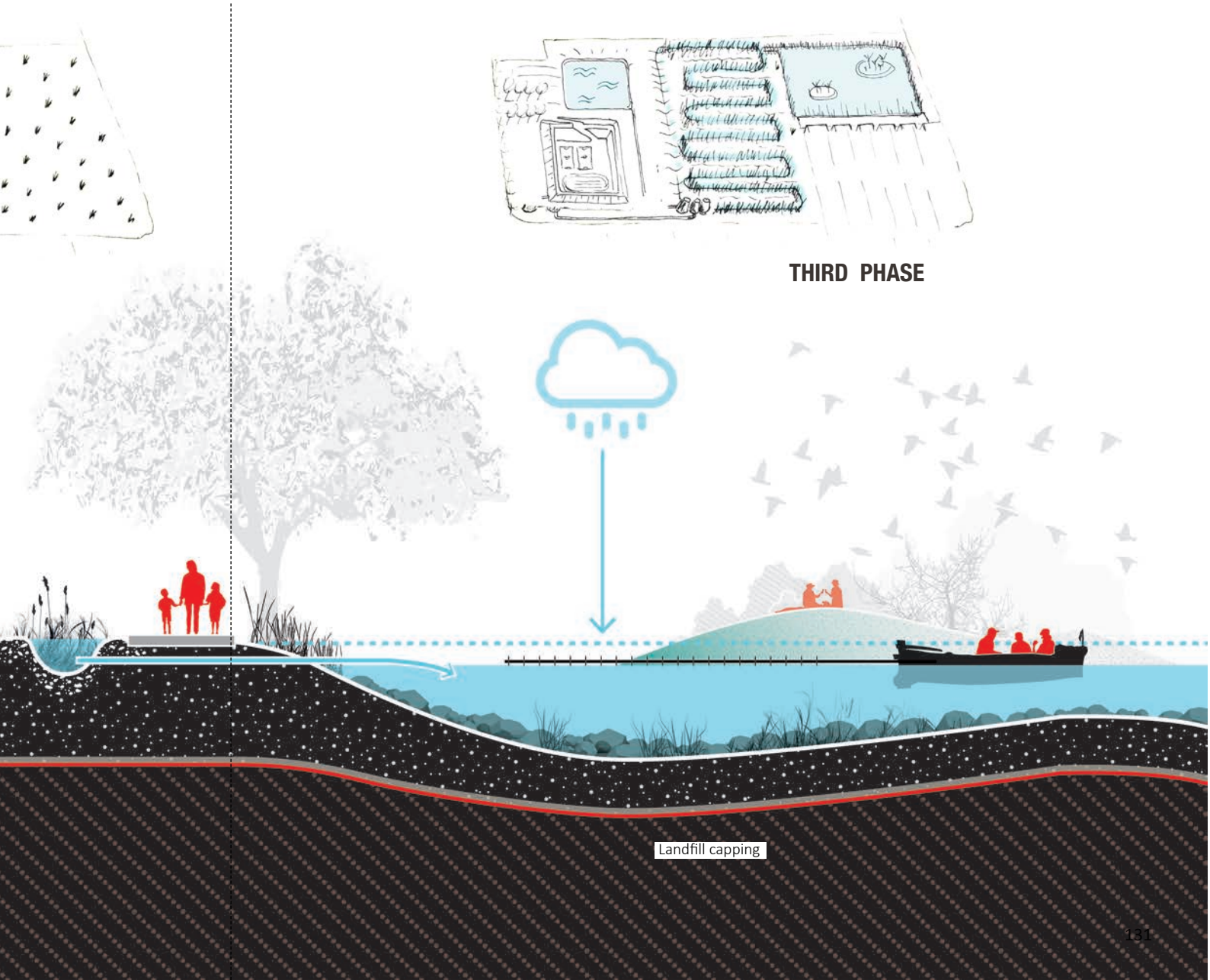


APPLICABLE ZONE

APPLICABLE TYPOLOGY

EXAMPLE PICTURE

THIRD PHASE

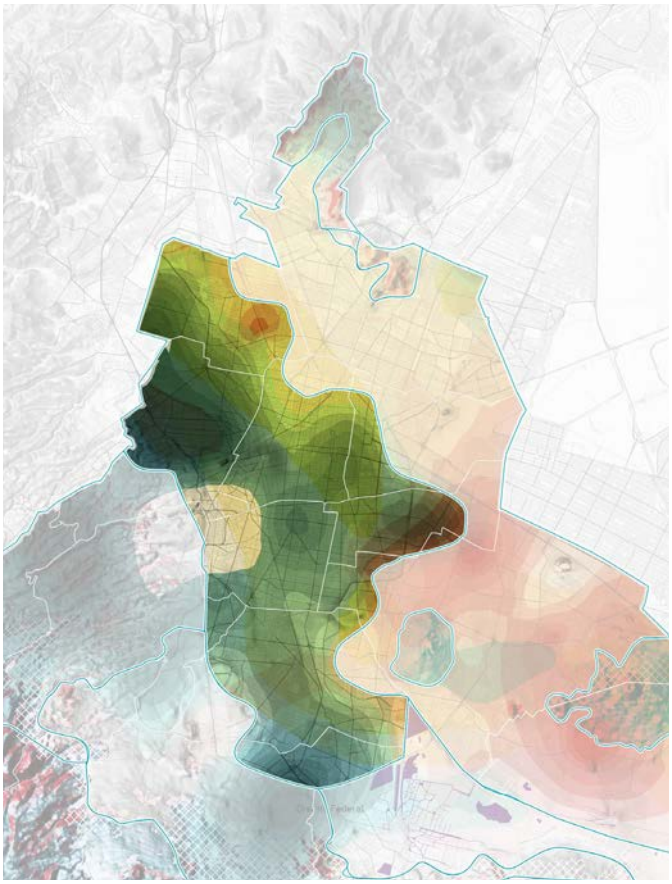


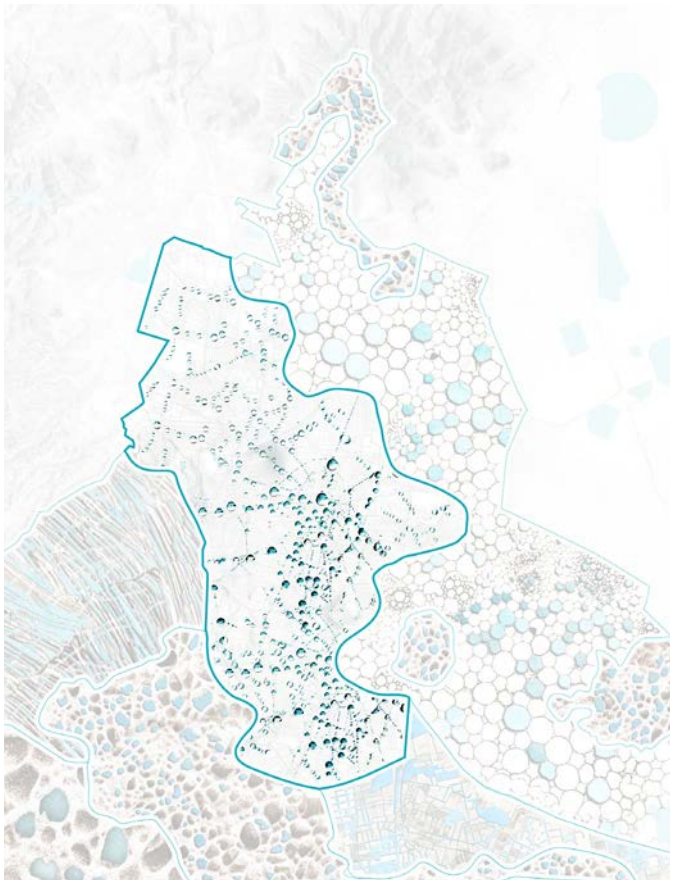
PUBLIC SPACE TYPOLOGIES TO RETAIN WATER

WEST BASIN_ORIGINAL FRESH LAKE

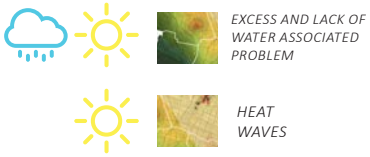
In the western basin the main goal is to retain the water, preferably as long as possible. But given the density of urban fabric and the insecurities concerning subsoil, drainage will probably always be necessary to a certain extent. This area consists of a dense urban fabric with a high pressure on public space. The overall quality of this public space is high and well maintained. We distinguish four different types of exemplary public space typologies that can be turned into a water sensitive public space:

- Urban plazas can become water plazas
- Urban streets can be designed in such way that they can flood smartly in emergency situations
- Intersections with leftover spaces are turned into a network of green bioswales
- Pop-up parks receive temporal water elements to raise public awareness





RISK



EXCESS AND LACK OF WATER ASSOCIATED PROBLEM

HEAT WAVES

Water Sensitive Strategy

Retain the drops of water on the surface to release at slow pace for reuse or drainage

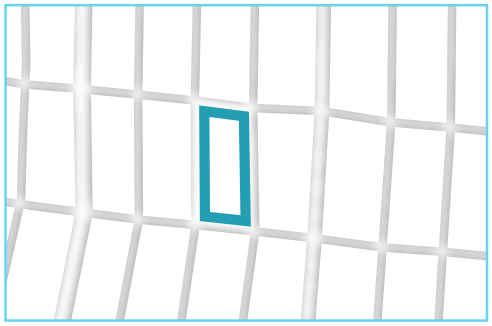
URBAN WATER SENSITIVE TYPOLOGIES

Schematic interpretation of the urban fabric of the eastern urbanized basin, illustrating the impact of different Water Sensitive public space typolgies.

5 URBAN PLAZA

→

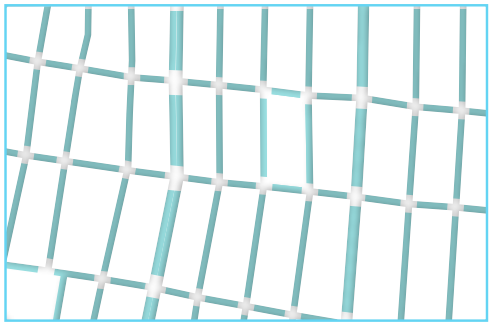
WATER PLAZAS



6 URBAN STREETS

→

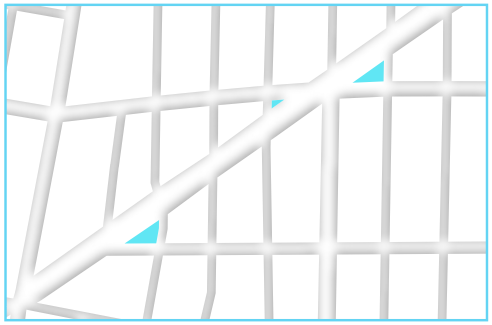
SMART FLOODABLE STREETS



7 INTERSECTIONS

→

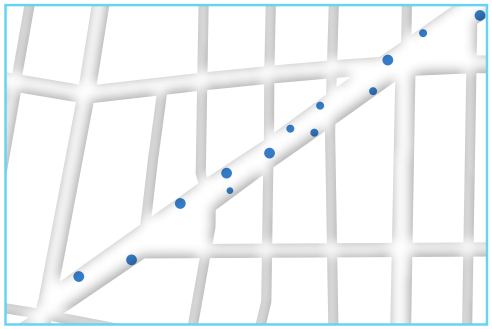
BIOSWALE XL



+1 POP-UP PARKS

→

TEMPORAL ELEMENTS

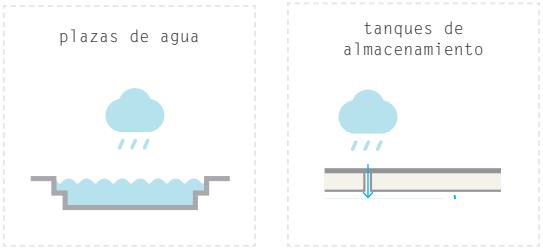


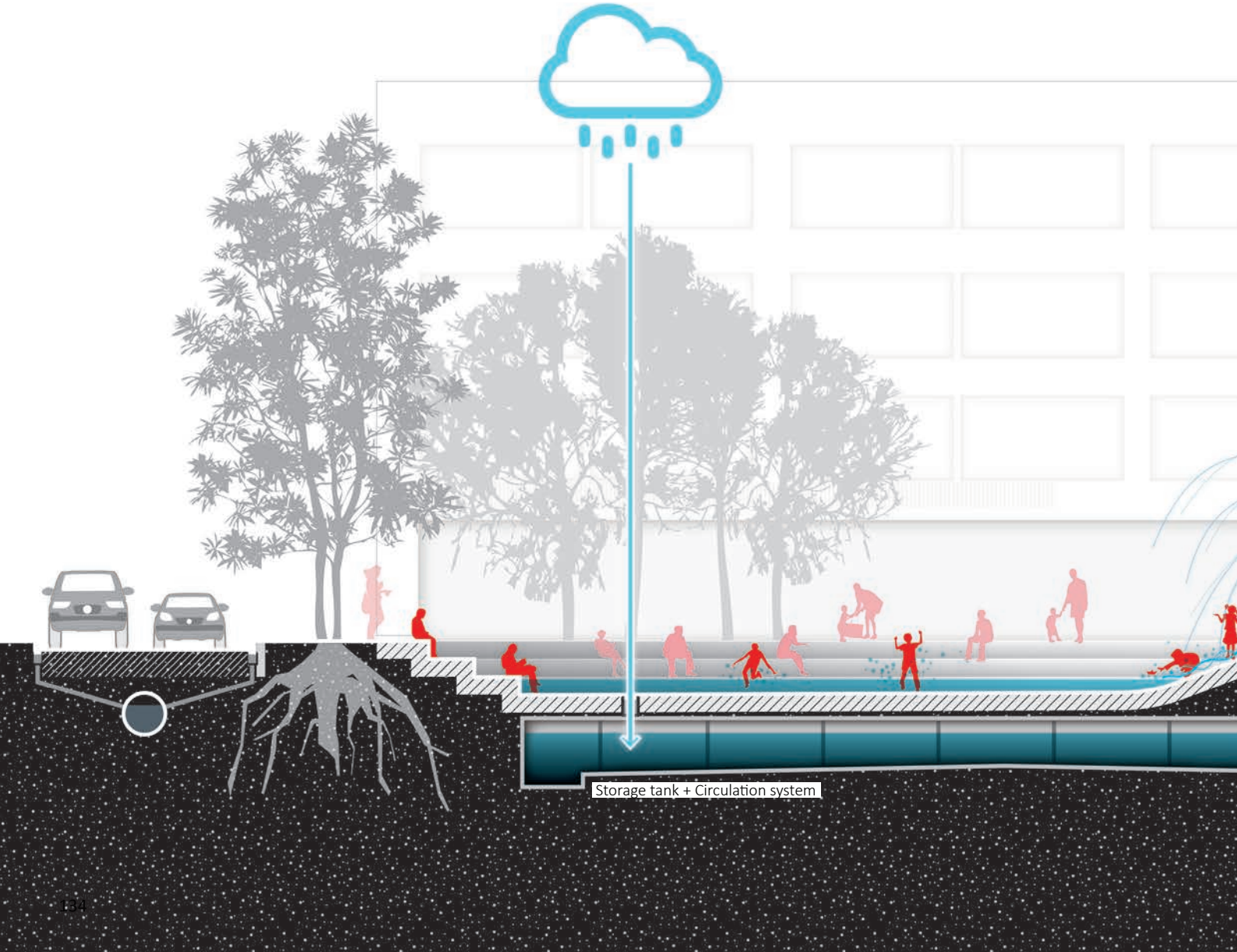
TYPOLOGY 5

TRANSFORMING URBAN SQUARES INTO WATER PLAZAS

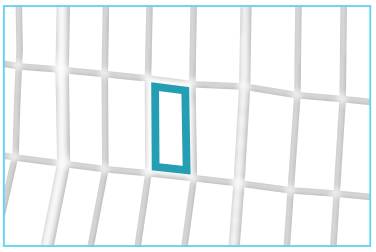
Many hard urban squares could have a multifunctional use as open air rain retention basins. By designing them in such a way that they can collect and contain water when heavy rains occur, the surrounding area is protected from flooding. The water storage is temporal and after the rain, it can be drained away or partly stored and filtered for local reuse (like in a fountain). During drier periods, the height differences needed for water retention, can offer fun possibilities for urban use and play.

APPLICABLE MEASURES



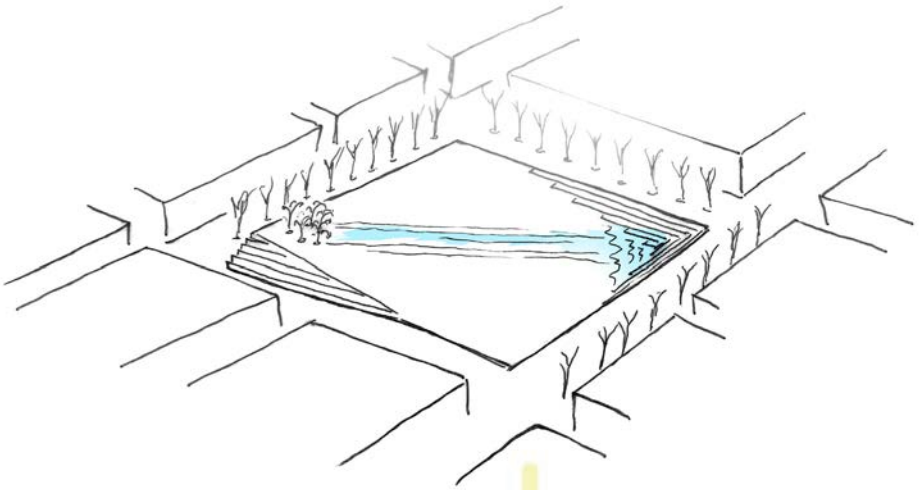


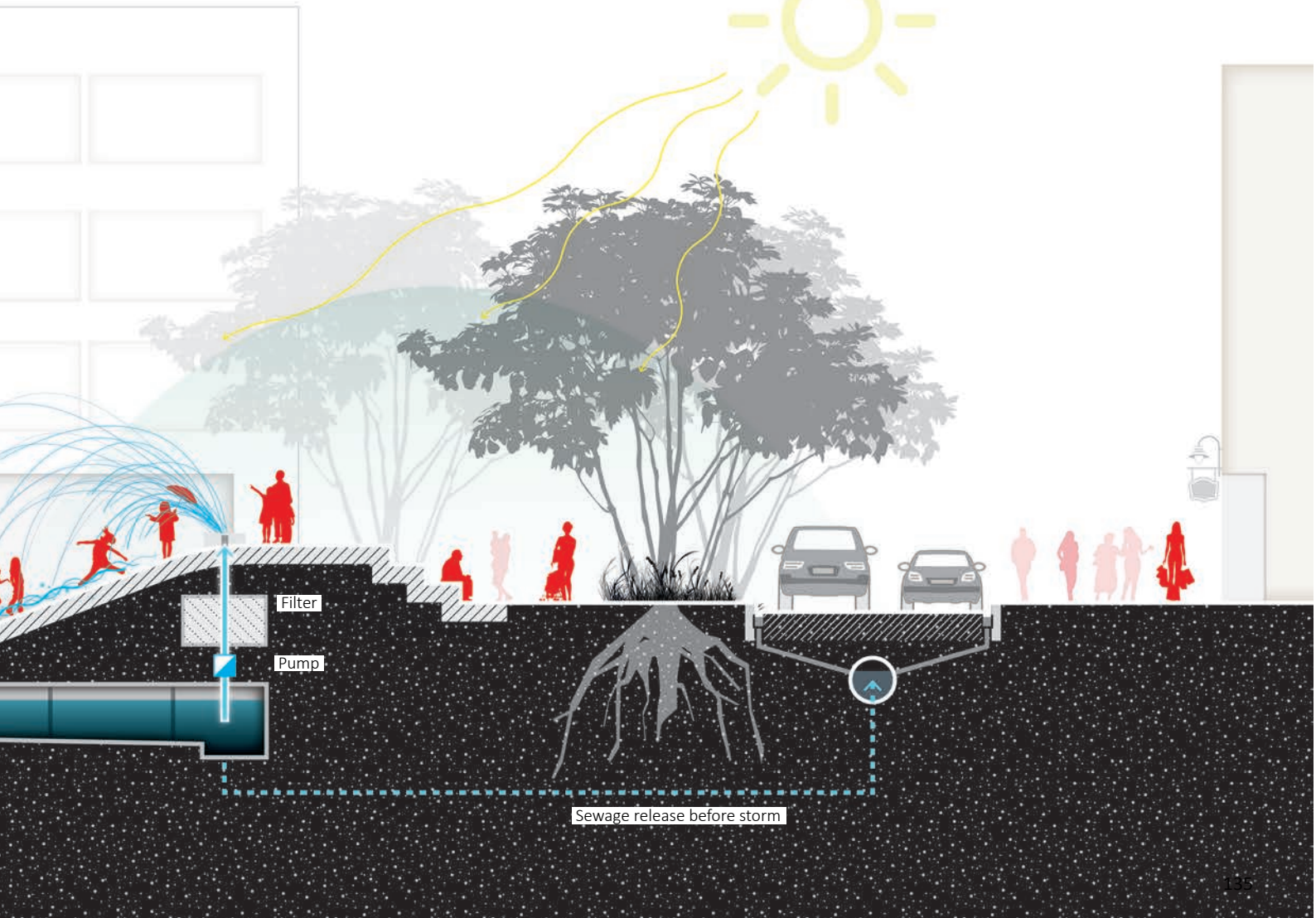
APPLICABLE ZONE



APPLICABLE TYPOLOGY

EXAMPLE PICTURE





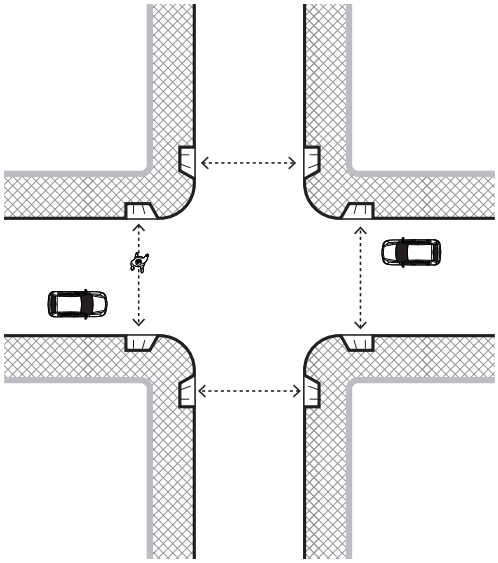
TYPOLOGY 6

TRANSFORMING URBAN STREETS INTO SMART FLOODABLE STREETS

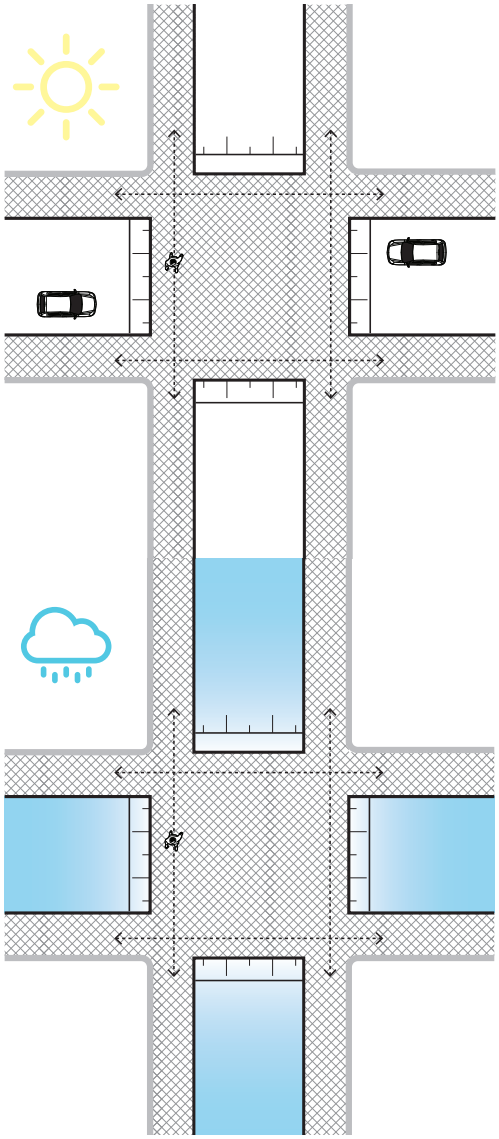
Regular urban streets can also be designed in such a way that they can purposefully and intelligibly flood. Many streets in the older neighborhoods of Mexico City are bordered by relatively high curbs, at times even more than twenty centimeters. This could allow the streets to flood whilst mitigating damage to adjacent residential and commercial real estate. That being said, in the event of a flood and the street becoming inundated, pedestrians would not be able to cross the streets without walking ankle-deep in water. It would thus be pertinent to raise all crossings up to the level of the pavement, instead of sinking the pavement into the level of the street, allowing roads to flood and mimic shallow buckets in between slightly raised plateaus. Here pedestrians can cross the street without wetting their feet Additionally, in dry situations these raised plateaus can function as traffic calming facilities which pedestrians would also benefit.

APPLICABLE MEASURE

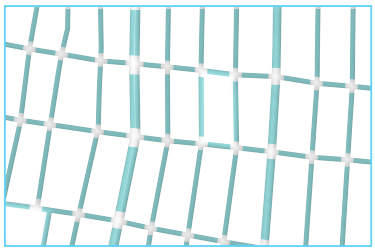
CURRENT SITUATION



PROPOSAL:
DRY SITUATION AND DURING HEAVY RAIN



APPLICABLE ZONE



APPLICABLE TYPOLOGY

EXAMPLE PICTURE

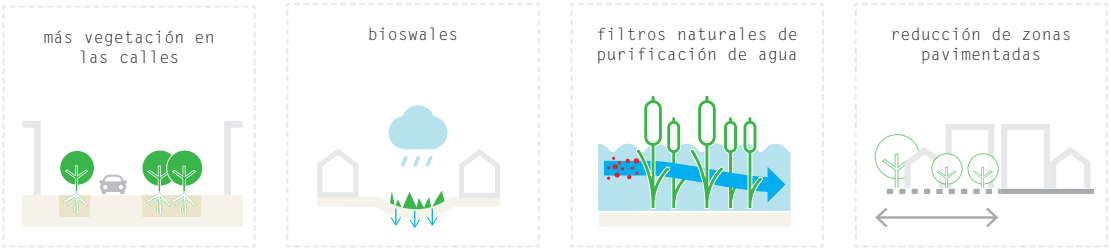
SMART FLOODING PREVENTS HINDRANCE FOR PEDESTRIANS

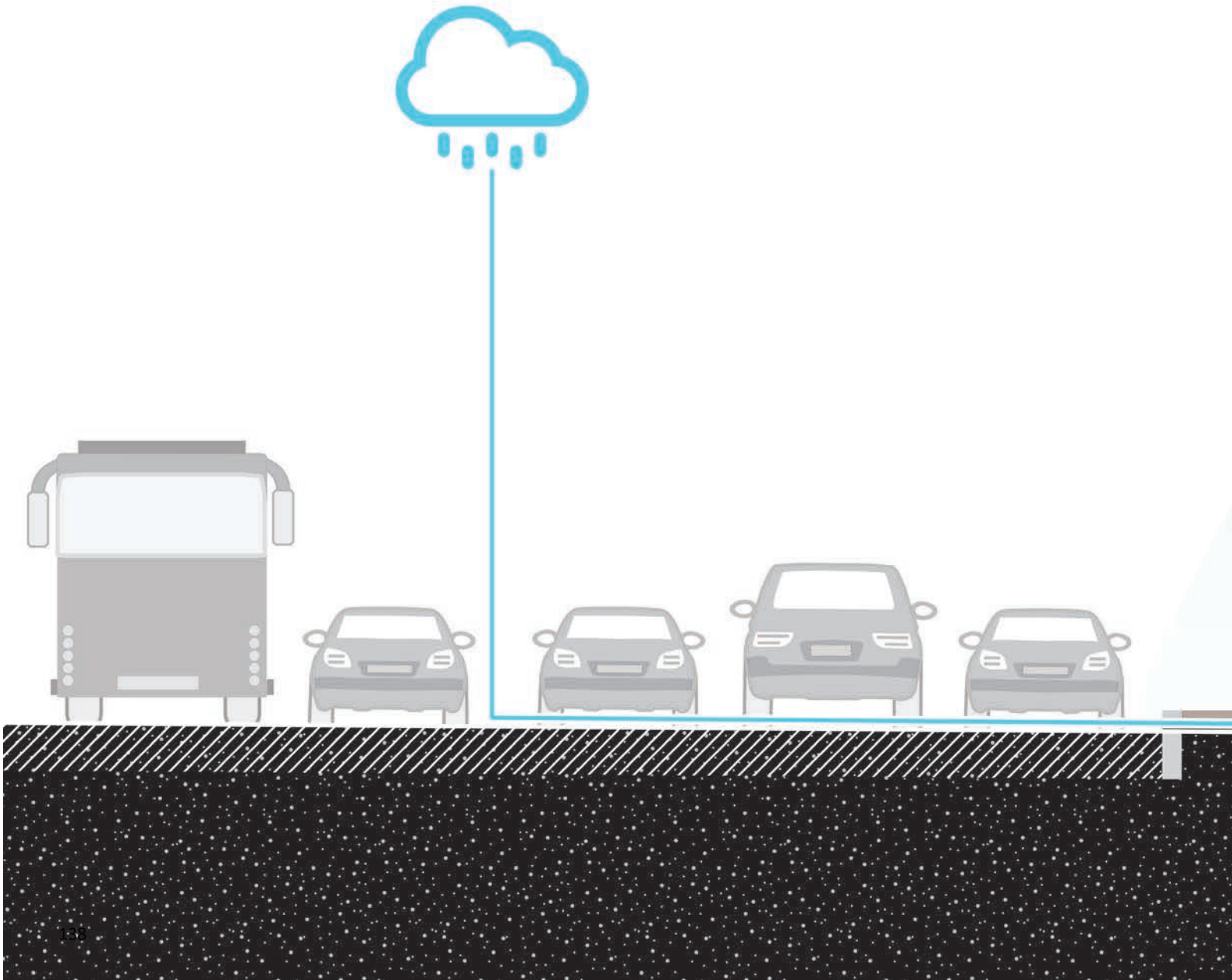
TYPOLOGY 7

TRANSFORMING INTERSECTIONS INTO A NETWORK OF XL BIOSWALES

Intersections are left over spaces in between large road infrastructure like 'Insurgentes' and the regular street grid of the city. Many of these triangular spaces are just paved over and left for parking cars or no use at all. Altogether they form a substantial surface that could be softened and used for greening the city. By turning these spaces into large bioswales, rain retention, partial on site cleaning and softening of the city can be combined. Since these spaces occur repetitively along the main roads, they could be interconnected via a tube network. This would allow the different bioswales to exchange water, when there is too much and also when there is too little. This makes them more resilient in the face of city's challenging weather conditions. Furthermore, their green qualities could provide the main roads with more lingering potential.

APPLICABLE MEASURES

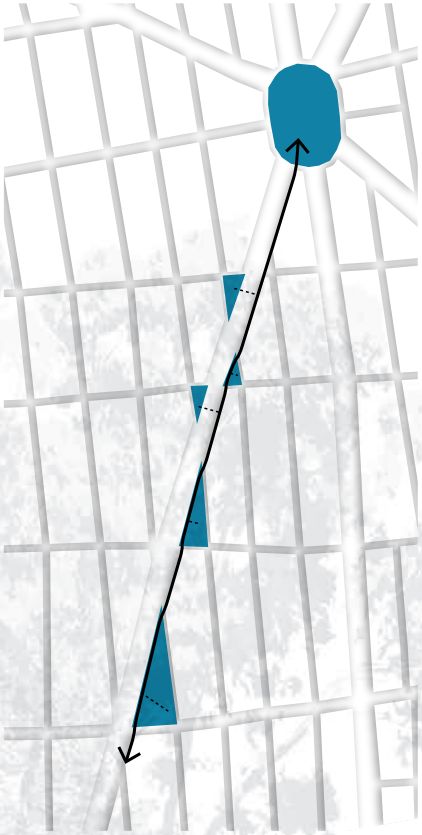




Overflow
Overflow
Rain pipe connected to the bioswale network

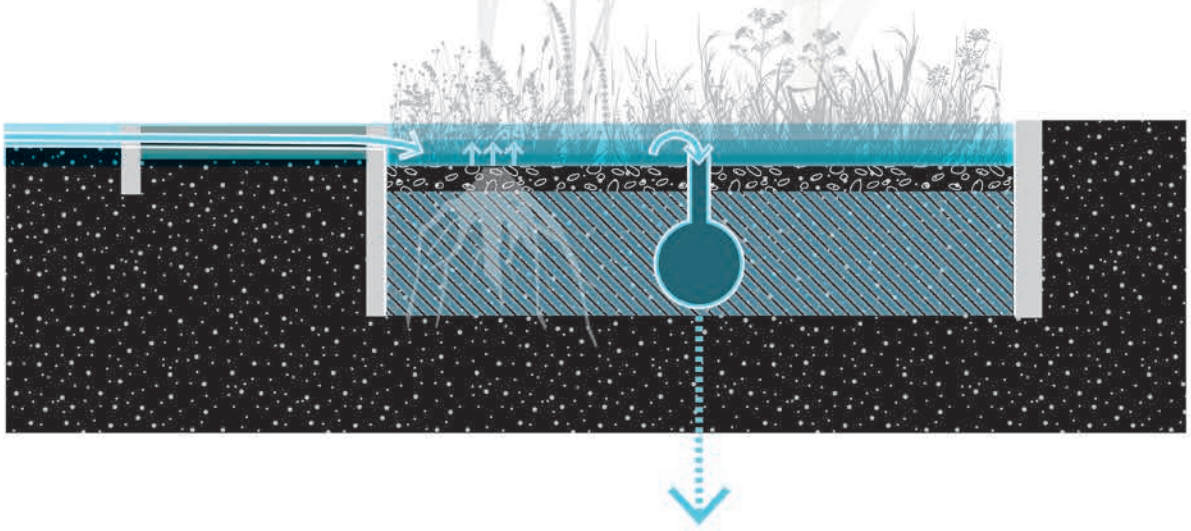
TYPOLOGY 7

HOW THE XL BIOSWALE NETWORK COULD WORK IN CASE OF FLOODS AND IN PERIODS OF DROUGHT

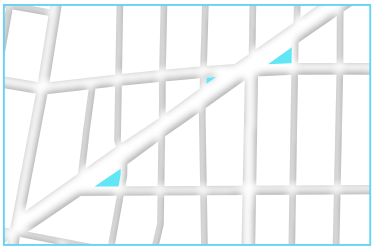


NETWORK OF INTERCONNECTED BIOSWALES

HEAVY RAIN OVERFLOWS INTO THE NETWORK AND DISTRIBUTES THE WATER



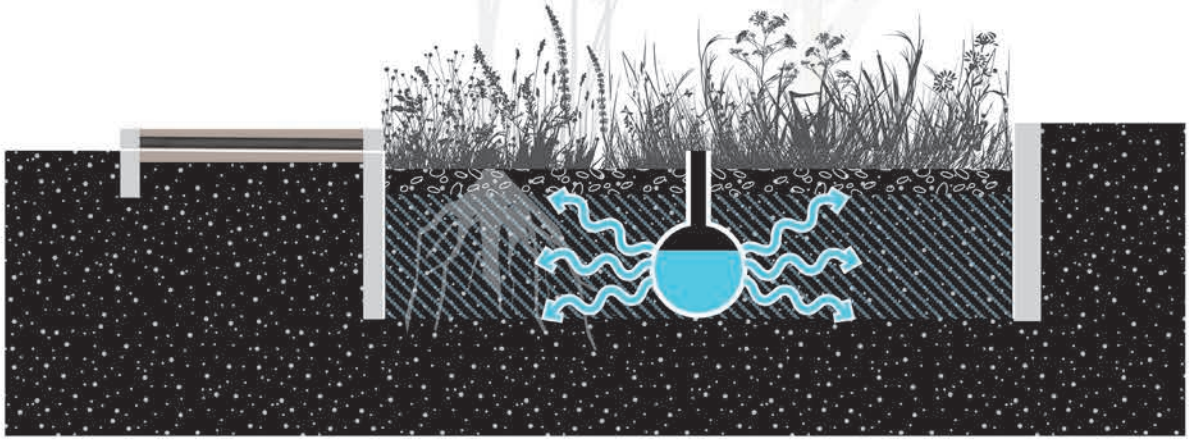
APPLICABLE ZONE



APPLICABLE TYPOLOGY

EXAMPLE PICTURE

IN DRY PERIODS THE NETWORK FUNCTIONS AS AN IRRIGATION SYSTEM TO HYDRATE THE BIOSWALES



TYPOLOGY +1

APPLYING TEMPORAL INTERVENTIONS IN POP-UP PARKS TO RAISE AWARENESS

Finally even temporary interventions can offer possibilities for a water sensitive approach. In Pop-up parks with loose seating elements and movable planters, water elements could be used to raise public awareness. For example, by creating a functional seating element that can also be used to water the planters, a clear message can be brought across that spilling drinking water in Mexico City is undesirable. This would likely need to be reinforced in combinations with making water more publicly visible, explaining its value as a scarce resource and offering a guaranteed and equitable safe supply to everyone.

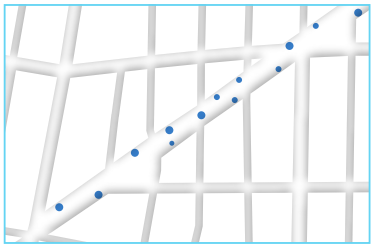
APPLICABLE MEASURE

awareness

STORING WATER IN FUNCTIONAL PUBLIC STREET FURNITURE

STORING WATER AS PUBLIC ART

APPLICABLE ZONE



APPLICABLE TYPOLOGY

EXAMPLE PICTURE

REDUCE SPILLING RESOURCES

SECURE SUPPLY

VISIBILITY OF ASSET

CREATE AWARENESS

WATER SENSITIVE WORK IN PROGRESS...

PARQUE LINEAL PASEO DE LA VIGA

RECOMMENDATIONS

SUGGESTIONS FOR NEXT STEPS

CHAPTER 7

Water sensitivity asks for adaptive, multifunctional infrastructure and urban design reinforcing water sensitive behaviors. This implies offering solutions beyond the technical measures in which people can be engaged. We are convinced the answers cannot be found solely in more extensive technical systems trying to solve one specific problem in isolation. Therefore answers should be found in a more holistic approach in which public space design and water management are being integrated into a more comprehensive strategy.

Following the motto: 'Delay, retain, store, reuse and drain only when necessary' a catalogue of water sensitive measures have been illustrated and connected to different zones in the city where they can be most effective. In the last chapter we have illustrated 7+1 water sensitive public space typologies that can be applied in the lower urbanized basin of Mexico City. They combine effective measures to solve water related problems and improve public space quality at the same time.

Mexico City is an extremely large metropolis and meeting its challenging water demands is a complex task. This study makes a serious attempt to offer the perspective of the water sensitive city in which public spaces can act as rain water management strategies. It could be the beginning of a comprehensive, effective and truly holistic strategy towards a water sensitive Mexico City. In order to get there we conclude this report with several suggestions for the next steps to take.

1. Centralize data and available information

It will be valuable when the existing data and information of Mexico City can be easily accessible in one central database. The most relevant data are:

- Soil moisture and detailed evaporation rates
- Land use maps
- Inundation maps and potential associated damage
- Detailed height maps/ vertical deformation/ subsidence maps
- Detailed rainfall and meteorological data
- Soil type maps and sections throughout the basin
- Ground water balance
- Social-economic maps
- Property maps (cadastral data)

2. Refine performance indicators for water sensitive measures

Deepening of the water, soil and urban system analysis of Mexico City is necessary to better understand and indicate which specific water sensitive measures are most appropriate for which location. We could specify further the important indicators which determine this relationship. This also includes identifying the positive and negative effects of various types of measures as they have been proposed. Questions to further examine are:

- What are the relevant performance indicators, how to define these indicators and what the best way to express them for different spaces like urban parks, streets, etcetera
- What are the effects on insects like mosquitos, water quality and garbage dumping. In short: health effects should be included.
- Reflect the measure in relation to competing functions in search of space (mobility, road safety, recreational functions, etcetera).
- Maintenance strategies and related costs

Because water has to compete with a lot of other functions in the public space, it is recommended to include the cost-benefit analysis of different types of measures and their added values related to “ecosystem services”.

3. Refine the product

The catalogue of possibilities offers a first and relevant overview for Mexico City. It is far from complete in both its depth as in its broadness. The catalogue can be connected to a wider range of different public space typologies and locations. Each measure out of the catalogue could contain information about:

- Best practices, data about functionality, features and cost-benefits
- Climate Performance indicators
- Preferential vegetation types
- Technical specification of measures
- Cost – benefits calculations
- Maintenance strategy and costs

The catalogue could be supported by guidelines for best practices concerning different typologies and specific communication to target groups. This catalogue could be built as a web-tool that leads its users through a menu, to come to the most suitable solutions for a particular location or typology. The outcome could be supported by an overview of performance indicators. As a product it would be constantly evolving.

4. Connect to resilience ambitions and climate change challenges

In the context of the membership of the 100 Resilient Cities network, Mexico City is working on a comprehensive resilient city strategy. In this strategy, Mexico City is meeting the challenge of becoming increasingly robust, resilient and sustainable regarding aspects like: water availability, aquifer resources, flood risk, drinking water, water quality, health, climate adaptation and subsidence. The ambition of the AEP to invest in water sensitive urban design contributes to the overall ambitions of the city's strategy. It would be interesting to quantify to which extent a water sensitive public space strategy could contribute to the objectives of the resilient cities strategy.

It would be useful if the water sensitive strategy could be linked to the climate change challenges of Mexico City. This requires insight into the effects of climate change in the city, expressed in extreme weather conditions and the impact of floods and droughts.

5. Realize more showcases of water sensitive public space

AEP is currently finishing its first water sensitive public space in Mexico City with the redesign and construction of 'Parque lineal Paseo de la Viga'. A next showcase in Iztapalapa is being prepared. The goal would be to unroll this water sensitive ambition over the entire city. Specific opportunities to be considered include:

A large part of the current drainage system will be reconstructed thanks to a world bank funding. For the short term this means many roads will be opened and under construction. This could also be the moment to re-profile the street into a water sensitive street design. This basically means reorganizing the street surface more intelligibly instead of bluntly reconstructing the original situation. It will need fine tuning in planning operations.

To be responsive to future developments it would be wise to develop a precise water sensitive strategy for primary roads and urban highways, specifically in relation to conflicting claims for space (a recipe for a so called "the perfect street")

For future large scale maintenance schemes of the drainage system it is desirable to develop an alternative on grey infrastructure projects. Instead of putting a lot of money in reconstructing the current drainage system, one could exercise what could be done with the same amount of money invested in blue-greens solutions and compare these solutions in their effect, performance indicators and cost-benefits.

In addition to developing singular public spaces it can be effective to upscale them into a 'climate proof neighbourhood' that links several individual projects into one more comprehensive water cycle for an entire city quarter.

Continue on developing the concept of water sensitivity. One can go from singular goals to a 'super multifunctional' public space including: retention, permanent water circulation, cleaning and purification, water reuse, urban play facilities, options for real estate (re)development, and the promotion of social cohesion in neighborhoods as mutually inclusive units .

6. Take steps towards integral design and politics

The water sensitive strategy for Mexico City in this report involves large scale concepts which include the entire watershed and thus extend the 'AEP work field' into the 'SEDUVI territory'. A comprehensive strategy asks for a cross governmental consensus about this approach. The same counts for the sewerage network. One can only do so much if public space is being considered separately. In close connection with sewerage interventions, this can be more effective in terms of costs and in terms of added values for the public domain of the city. Here SACMEX territory is involved and integrated into the design task.

Both will be inevitable in order to make real substantial contributions to solving problems as well as adding quality space to the city at the same time. Moreover, it is about using valuable resources wisely. An integral approach and combining different sectors means making better use of scarcely available resources like water, urban space and funding. Aspects of governance and social responsibility are also vital in this. Holism is about combining the tasks concerning public space, water management, mobility and urban development in one integrated design approach.

This is not an easy task and it will need some good fate in which this study strives to help create good conditions, or as a Chinese saying goes: 'Luck is what happens when preparation meets opportunity'.

CREDITS

This report

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February workshop participants

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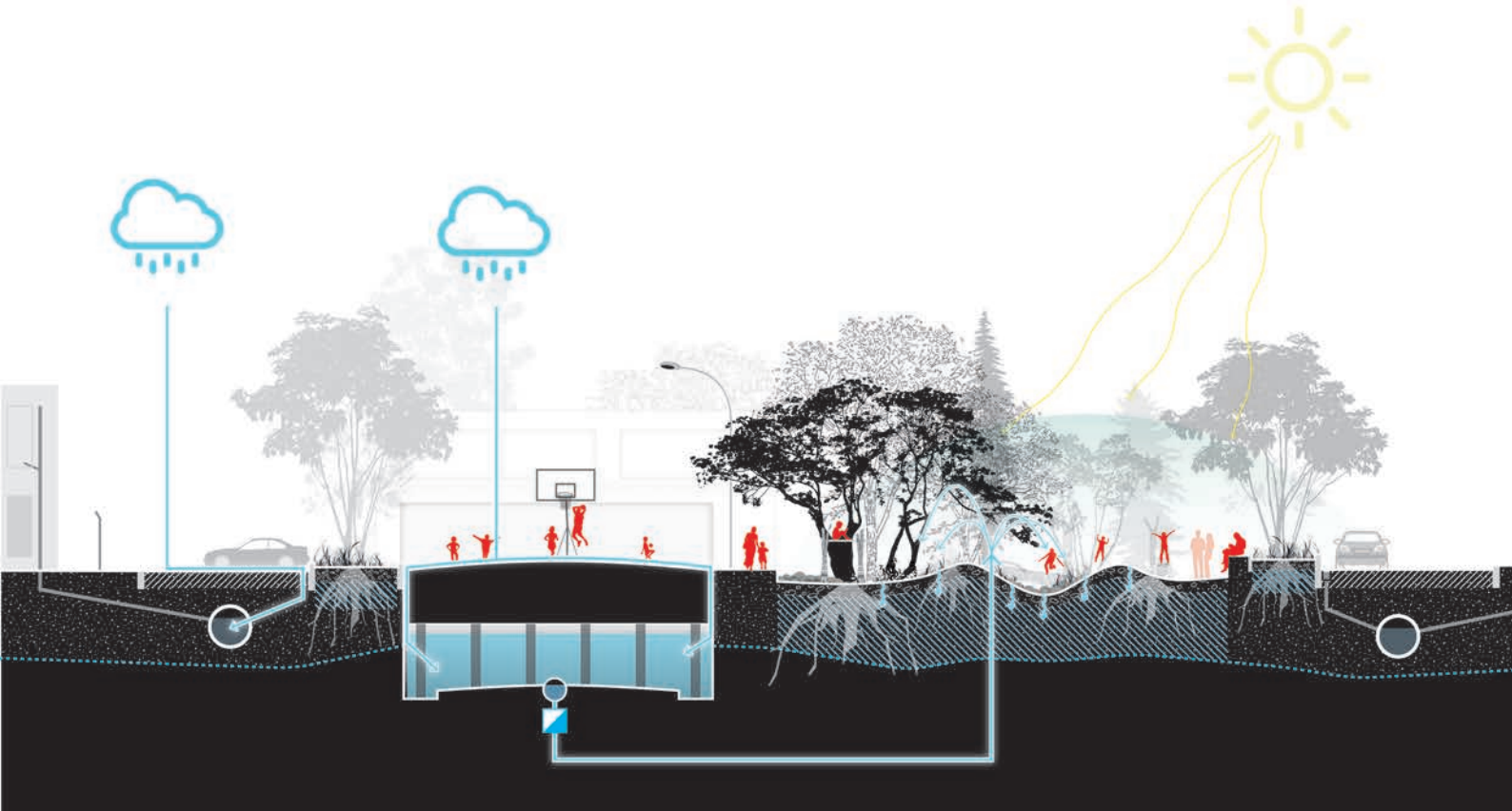
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